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User's Guide to the MESOPUFF II Model and Related Processor Programs

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USER'S GUIDE TO THE MESOPUFF II
MODEL AND RELATED PROCESSOR PROGRAMS

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A complete set of user instructions are provided for the MESOPUFF II regional-scale air quality modeling package. The MESOPUFF II model is a Lagrangian variable-trajectory puff superposition model suitable for modeling the transport, diffusion, and removal of air pollutants from multiple point and area sources at transport distances beyond the range of conventional straight-line Gaussian plume models (i.e., beyond $\sim$ 10-50 km). It is an extensively modified version of the MESOscale PUFF (MESOPUFF) model with refined and enhanced treatment of advection, vertical dispersion, removal, and transformation processes.

The MESOPUFF II model is one element of an integrated modeling package that also includes components for preprocessing of meteorological data (READ56, MESOPAC II) and postprocessing of concentration data MESOFILE II). Complete user instructions and test case input/output are provided for each of these programs.

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This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This publication contains a technical description and instructions for the use of the MESOPUFF II model and its processor programs. The preprocessor programs need hourly meteorological surface, twice-daily upper air, and hourly precipitation (optional) data in the formats archived by the National Climatic Center in Asheville, North Carolina. The model utilizes the Gaussian puff superposition approach to simulate a continuous pollutant plume. The model is capable of multi-day simulations and has algorithms for plume rise, transport, chemical transformations, dry deposition, and wet removal. Terrain variations are not accounted for in the model.

The puff superposition approach has not been used extensively in air quality models for the prediction of pollutant concentrations. MESOPUFF II is being made available to promote testing and evaluation of the methods and optional features in the model. MESOPUFF II has no regulatory standing and its application for regulatory purposes should be considered in light of EPA's Guideline on Air Quality Models.

The model version (1.0) documented in this publication represents an attempt to utilize recent scientific information to realistically account for the relevant physical processes active on the regional to long-range scales. Modifications may be made in the future based on results by users and findings from ongoing research programs.

Although attempts have been made to check the computer program code, errors may be found occasionally. Adjustments to the code to suit different computer systems may be required. If there is a need to correct, revise, or update this model, changes may be obtained as they are issued by completing and sending the form on the last page of this guide.

It is anticipated that MESOPUFF II will be made available in the future on the User's Network for Applied Modeling of Air Pollution (UNAMAP) system. A tape of this model or the UNAMAP system may be purchased from NTIS for use on the user's computer system. For information on UNAMAP contact: Chief, Environmental Operations Branch, MD-80, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

ABSTRACT

A complete set of user instructions are provided for the MESOPUFF II regional-scale air quality modeling package. The MESOPUFF II model is a Lagrangian variable-trajectory puff superposition model suitable for modeling the transport, diffusion, and removal of air pollutants from multiple point and area sources at transport distances beyond the range of conventional straight-line Gaussian plume models (i.e., beyond ∿ 10-50 km). It is an extensively modified version of the MESOscale PUFF (MESOPUFF) model (Benkley and Bass 1979) with refined and enhanced treatment of advection, vertical dispersion, removal, and transformation processes.

The MESOPUFF II model is one element of an integrated modeling package that also includes components for preprocessing of meteorological data (READ56, MESOPAC II) and postprocessing of concentration data (MESOFILE II). Complete user instructions and test case input/output are provided for each of these programs.

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SECTION 1
INTRODUCTION

1.1 Background

The regional and long-range transport and transformation of sulfur oxides and nitrogen oxides emitted from major point sources are of increasing concern. Motivated by the need for easily-used, cost-efficient mesoscale air quality models suitable for regulatory applications, the National Oceanic and Atmospheric Administration (NOAA) sponsored a study by Environmental Research & Technology, Inc. (ERT) to develop, compare, and evaluate a set of mesoscale models and related processor programs known as the MESO-models (Benkley and Bass 1979a, b, c; Morris et al. 1979; Scire et al. 1979). One of these models, the MESOscale PUFF (MESOPUFF) model appears to be well suited for regulatory use. For this reason, the Environmental Protection Agency (EPA) has sponsored a second study by ERT to enhance the capabilities and flexibility of the MESOPUFF model to meet the current and future needs of EPA in predicting mesoscale transport of pollutants, especially secondary aerosols.

This report is the second volume of a two-volume set describing the results of this effort to extend MESOPUFF's capabilities. Extensive modifications have been made to MESOPUFF in order to refine and enhance its treatment of advection, vertical dispersion, removal and transformation processes. The new model has been designated MESOPUFF II. The objective of this document is to provide a summary of the basic model equations and provide a complete set of user instructions for the MESOPUFF II model and its related processor programs (READ56, MESOPAC II, MESOFILE II). The companion report, entitled "Development of the MESOPUFF II Dispersion Model" contains a complete description of the scientific and operational bases for the modifications made to MESOPUFF.

The next section outlines the MESOPUFF II modeling package and describes the functions of each program. Section 1.3 contains a summary of the major modifications made in MESOPUFF II. Section 1.4 defines the input requirements of the programs. The second chapter contains a technical description of model algorithms. A complete set of user instructions is contained in the third chapter. Program flow diagrams are provided in Appendix A. Test case input and output for each program are contained in Appendices B-E.

1.2 MESOPUFF II Modeling Package

The MESOPUFF II model is one element of an integrated modeling package. This modeling package, illustrated in Figure 1, also contains components for preprocessing of meteorological data (READ56, MESOPAC II) and postprocessing of predicted concentration results (MESOFILE II). Each component of the MESOPUFF II modeling package is briefly described below.

READ56 is a preprocessor program that reads and processes the twice-daily upper air wind and temperature sounding data available from the National Climatic Center (NCC) for selected stations. READ56 extracts the data required by the MESOPAC II program from a standard-formatted NCC tape (TDF5600). READ56 scans the upper air data for completeness; warning messages are printed to flag missing or incomplete soundings. A file of processed sounding data is created in a format convenient for possible editing by the user. This file is subsequently input into the MESOPAC II program.

MESOPAC II is the meteorological processor program that computes the time and space interpolated fields of meteorological variables (e.g., transport winds, mixing height) required by MESOPUFF II to describe mesoscale transport and dispersion processes. MESOPAC II reads the upper air data files created by READ56 and files of standard-formatted NCC hourly surface meteorological data (CD144) and precipitation data (TD9657). A single output file containing the derived meteorological fields is produced which serves as an input file to MESOPUFF II.

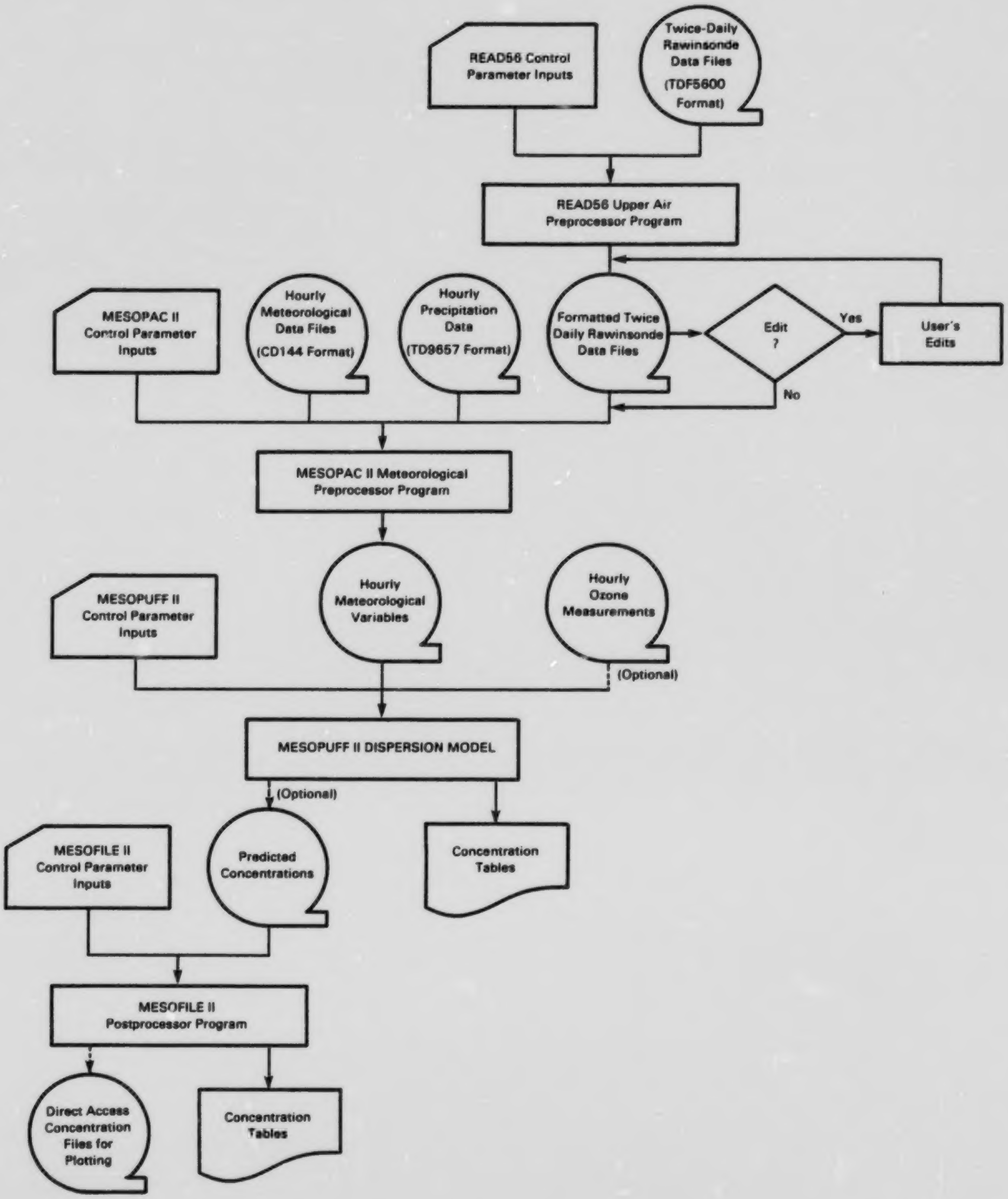
READ56 Control Parameter Inputs
Twice-Daily Rawinsonde Data Files (TDF5600 Format)
READ56 Upper Air Preprocessor Program
MESOPAC II Control Parameter Inputs
Hourly Meteorological Data Files (CD144 Format)
Hourly Precipitation Data (TD9657 Format)
Formatted Twice Daily Rawinsonde Data Files
Edit ?
Yes
User's Edits
No
MESOPAC II Meteorological Preprocessor Program
MESOPUFF II Control Parameter Inputs
Hourly Meteorological Variables
Hourly Ozone Measurements
(Optional)
MESOPUFF II DISPERSION MODEL
(Optional)
MESOFILE II Control Parameter Inputs
Predicted Concentrations
Concentration Tables
MESOFILE II Postprocessor Program
Direct Access Concentration Files for Plotting
Concentration Tables
8304011

Figure 1 MESOPUFF II Modeling Package

MESOPUFF II is a Gaussian, variable-trajectory, puff superposition model designed to account for the spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanisms encountered on regional scales. With the puff superposition approach, a continuous plume is modeled as a series of discrete puffs (Figure 2). Each puff is transported independently of other puffs. A puff is subject to growth by diffusion, chemical transformations, wet removal by precipitation, and dry deposition at the surface. Up to five pollutants may be modeled simultaneously.

F 2

MESOFILE II is a postprocessing program that operates on the concentration file produced by MESOPUFF II. The postprocessing functions available with MESOFILE II include flexible time averaging of gridded or non-gridded (discrete) receptor concentrations, line printer contour plots of concentration fields, statistical analysis of point-by-point or bulk differences between concentration fields, and summing and scaling capabilities.

1.3 Major Features of MESOPUFF II

The original MESOPUFF model is a single-layer, two species puff superposition model. Its meteorological preprocessor (MESOPAC) creates gridded fields of wind components, mixing height, and stability class from twice-daily rawinsonde (upper air) data. Chemical transformation of sulfur dioxide to sulfate is modeled with a spatially and temporally constant transformation rate. Dry deposition is modeled with a constant deposition velocity for each pollutant by the source depletion technique.

Table 1 outlines the most important modifications made in MESOPUFF II and its processor programs. MESOPAC II supplements twice-daily rawinsonde data with hourly surface data to construct wind fields at two levels. The greater temporal and spatial resolution of the surface data allows improved treatment of plume transport. Wind fields are constructed at two user-selected levels: a lower level to represent boundary layer flow and an upper level to represent flow above the boundary layer.

T 1

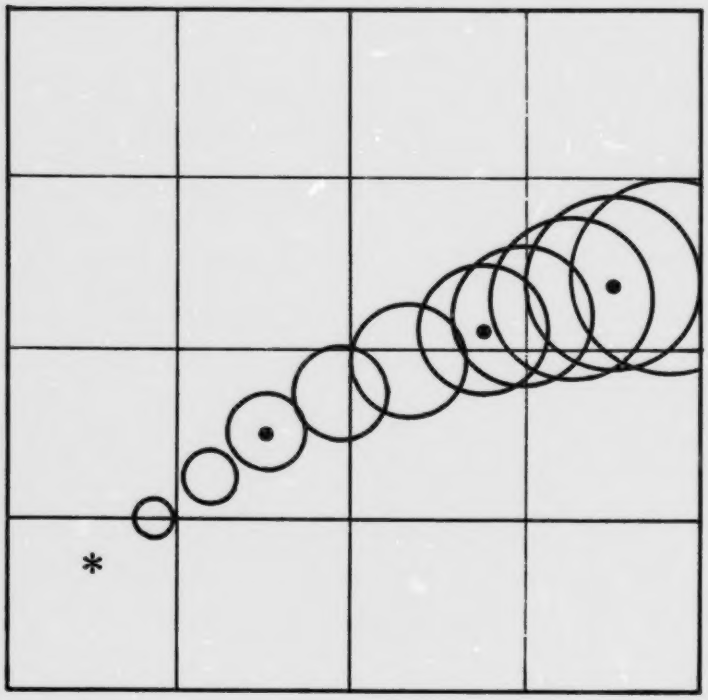

Figure 2 Schematic Representation of Puff Superposition Approach

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TABLE 1. MAJOR FEATURES OF MESOPUFF II

- Uses hourly surface meteorological data and upper air rawinsonde data
- Wind fields constructed for two layers (within boundary layer, above boundary layer)
- Boundary layer structure parameterized in terms of micrometeorological variables u_*, w_*, z_i, L
- Up to five species (e.g., SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-)
- Space- and time-varying chemical transformations
- Space- and time-varying dry deposition; resistance model; source or surface depletion
- Space and time-varying wet removal
- Efficient puff sampling function.

The additional information contained in the surface meteorological observations allows calculation of important micrometeorological variables that determine the structure of the boundary layer (i.e., surface friction velocity, u_*, convective velocity scale, w_*, Monin-Obukhov length, L, and boundary layer height, z_i). These variables are computed by MESOPAC II from surface meteorological data and surface characteristics (i.e., land use, roughness length) provided by the user for each grid point.

MESOPUFF II has been expanded to accommodate up to five pollutants: sulfur dioxide (SO_2), sulfate ($SO_4^=$), nitrogen oxides ($NO_x = NO + NO_2$), nitric acid (HNO_3), and nitrate (NO_3^-). Chemical transformation rate expressions have been developed from the results of photochemical model simulations over a wide range of environmental conditions. The rate expressions include gas phase NO_x oxidation, and gas/aqueous phase SO_2 oxidation. The $HNO_3/NH_3/NH_4NO_3$ chemical equilibrium relationship has also been incorporated into the model.

The dry deposition of pollutants is treated in MESOPUFF II with a resistance model. The pollutant flux is proportional to the inverse of a sum of resistances to pollutant transfer through the atmosphere to the surface. The resistances depend on the characteristics of the pollutant, the underlying surface, and atmospheric conditions. MESOPUFF II contains options for the commonly used source depletion model of dry deposition (i.e., pollutant is removed from the entire depth of the puff) or the more realistic surface depletion treatment (i.e., material is removed only from the surface layer) with a 3-layer submodule.

Precipitation scavenging is frequently the dominant pollutant removal mechanism during precipitation periods. MESOPUFF II contains a scavenging ratio formulation for wet removal. The scavenging ratio depends on both the type and rate of precipitation, and the characteristics of the pollutant.

Improvements in MESOPUFF II have been made in the method which evaluates and sums the contributions of individual puffs to the total concentration. The model uses an integrated form of the puff sampling function that eliminates the problem of insufficient puff overlap commonly encountered with puff superposition models. This development allows continuous plumes to be accurately simulated with fewer puffs, thereby saving computational time and reducing computer storage requirements.

1.4 Summary of Required Input Data

The required input data for MESOPUFF II and its preprocessors may be classified into four types: (1) run control parameters, (2) meteorological data, (3) surface classification (land use) data, and (4) source and emissions data. If available, hourly ozone measurements may also be input to the model. The values of the run control parameters for each program are selected by the user to define a run. For example, the starting date and length of a run, the technical options used, and control of input/output options are all determined by values of the run control parameters chosen by the user. Chapter 3 contains a complete description of all the run control parameters for each program.

The meteorological data inputs required by MESOPAC II are twice-daily upper air soundings, hourly surface meteorological observations, and hourly precipitation measurements. The program is designed to use standard-formatted meteorological files available from NCC. The upper air soundings are routinely obtained twice a day at 00 GMT (7 pm EST) and 12 GMT (7 am EST). The READ56 program extracts the following information for each sounding level:

- pressure
- height
- temperature
- wind direction
- wind speed.

The required format for upper air data is the Standard Tape Deck Format 5600 series (TDF5600).

The hourly surface meteorological data for MESOPAC II consists of the following information:

- cloud cover
- ceiling height
- precipitation type
- wind speed
- wind direction
- surface pressure
- temperature
- relative humidity

The required format for the surface observations is Card Deck 144 (CD144). It should be noted that the surface observations must be at hourly intervals.

The CD144 formatted surface observations do not contain hourly precipitation amounts. However, hourly precipitation data are available at many surface stations in NCC Tape Deck 9657 (TD9657) format (previously Card Deck 488). MESOPAC II is designed to read two files for each surface meteorological station - one file containing CD144 observations and a second file containing TD9657 data.

The third type of required input data is a classification of the typical surface characteristics in each grid square. Although the user may optionally specify detailed information such as roughness length and canopy resistances, these data may not always be available. Therefore, the program requires only that land use categories be input for each grid cell. These data may be obtained from land use maps or digitized land use inventories available on tape such as the National Land Use and Land Cover Inventory (Page 1980). Pre-selected surface roughness lengths and canopy resistances associated with each land use category are then internally assigned to the grid cells. The land use categories and default values of associated surface roughness and canopy resistance are listed in Table 8.

MESOPUFF II models emissions from both point and area sources. The following information is required for each point source:

- source location (x,y in grid units)
- stack height
- stack diameter
- exit velocity
- stack gas temperature
- emission rate for each pollutant.

The area source option is primarily intended to allow modeling of the large number of small point and non-point sources within urban areas as one or more sources with an effective height and initial vertical and horizontal puff size specified by the user. The following information is required for each area source:

- location (x,y in grid units)
- effective height
- initial puff size (σ_y, σ_z)
- emission rate for each pollutant.

SECTION 2

TECHNICAL DESCRIPTION

2.1 Introduction

A brief description of the technical aspects of the MESOPUFF II model and its meteorological preprocessor, MESOPAC II, are contained in the following sections. The objective is to provide a concise summary of the basic model equations to aid the user in the selection of model options and inputs. A full description of the scientific and operational bases for the model algorithms is contained in a companion document (Scire et al. 1983).

The MESOPAC II meteorological preprocessor is described in Section 2.2. The components of MESOPUFF II are presented in Section 2.3.

2.2 MESOPAC II Meteorological Preprocessor

2.2.1 Wind Fields

MESOPAC II constructs hourly wind fields at each grid point at two user-selected vertical levels: a lower level wind field representing boundary layer flow, and an upper level wind field representing flow above the boundary layer. The lower level winds are used to advect puffs within the mixed layer and to determine the plume rise of newly released puffs. The upper level winds are used to advect puffs above the boundary layer. At each time step, the appropriate wind field for advection of a puff is determined by comparison of the height of the puff center with the spatially and temporally varying mixing height. If the puff center is above (below) the mixing height at the closest grid point, the entire puff is advected with the upper (lower) level wind.

Considerable flexibility is allowed in choosing the most appropriate level or vertically-averaged layer for each wind field. Table 2 contains the available options. The default instructions are to use the winds averaged through the mixed-layer for the lower level wind field, and the wind averaged from the top of the mixed layer through the 700 mb level ($\sim$ 3000 m) for the upper level wind field. However, if desired, the user may select other levels to determine the wind fields (e.g., surface and 850 mb levels). The model may be made effectively a single wind field model by specifying the lower and upper wind fields to be the same.

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The mixed layer averaged winds are calculated from twice-daily rawinsonde data from upper air stations and hourly surface data from the typically much denser network of surface stations. Layer-averaged wind speed and wind direction computed from the rawinsonde data are used to adjust the hourly surface winds. The following five step procedure, adapted from Draxler (1979), is used to determine the mixed-layer wind at each given point:

(1) A representative rawinsonde sounding (00 or 12 GMT) is selected based upon the stability class at the nearest surface station to the grid point and the time of day. Neutral/unstable and stable conditions are assumed to be represented by the 00 GMT and 12 GMT sounding, respectively.

(2) Using the sounding selected in Step (1), vertically averaged u (easterly) and v (northerly) wind components are computed through the layer from the surface to the grid point mixing height.

(3) The ratio, R, of the layer-averaged wind speed to the surface wind speed at the rawinsonde station, and the angular difference in wind direction, $\Delta\theta$, between the layer averaged and surface winds are calculated.

(4) The hourly surface wind data are used to calculate spatially interpolated surface wind components (u_s, v_s) at each grid point. Data from all surface stations within a user-specified 'scan-radius' of the grid point are used to compute (u_s, v_s) according to:

TABLE 2. OPTIONS FOR LOWER AND UPPER WIND FIELDS

Option	Meteorological Data
Vertically Averaged Winds	
Surface to mixing ht (1)	Surface, Rawinsonde
Mixing ht to 850 mb	Rawinsonde
Mixing ht to 700 mb(2)	Rawinsonde
Mixing ht to 500 mb	Rawinsonde
Single Level Winds	
Surface	Surface
850 mb	Rawinsonde
700 mb	Rawinsonde
500 mb	Rawinsonde

---

[1] Default lower-level wind field
[2] Default upper-level wind field

$$(u_s, v_s)_{ij} = \frac{\sum\limits_k \frac{\alpha_s}{r_s^2} \cdot (u_k, v_k)}{\sum\limits_k \frac{\alpha_s}{r_s^2}} \qquad (2\text{-}1)$$

where u_s, v_s are the easterly and northerly components of the surface wind at grid point (i, j),

u_k, v_k are the easterly and northerly components of the surface wind at surface station k,

r_s is the distance from the surface station to grid point (i, j), and,

α_s is an alignment weighting factor ($\alpha_s = 1-0.5\ |\sin \phi_s|$, where ϕ_s is the angle between the observed wind direction and the line from the surface station to the grid point).

For equal values of r_s, alignment weighting causes winds at a station directly upwind or downwind of a grid point to be weighted twice as heavily as winds for a station at right angles to the grid point.

(5) The mixed-layer averaged wind at the grid point is calculated by multiplying the surface wind speed at the grid point computed in Step (4) by the wind speed ratio, R, at the nearest rawinsonde site. Similarly, the surface wind direction is adjusted by the wind direction factor, $\Delta\theta$.

The surface wind components (u_s, v_s) in Step (4) must be computed each hour regardless of the user's choice of wind fields for advection because the surface winds are also required in the calculation of atmospheric stability and the micrometeorological parameters described in Sections 2.2.2 through 2.2.6.

Vertically averaged winds from the mixing height to the 850 mb, 700 mb or 500 mb levels are computed in the following manner. The 00 GMT and 12 GMT winds at each rawinsonde station are first interpolated in time, and then vertically averaged through the layer from the grid point mixing height to the appropriate level (e.g., 700 mb). The winds at grid point (i, j) are obtained by Equation 2-1, with the summation over rawinsonde stations instead of surface stations. Only rawinsonde stations within a 'scan-radius' of the grid point are considered. The mixing height must be lower than the pressure level which defines the top of the layer; otherwise, an error message is printed and execution of the program is terminated.

If one of the single-level upper air wind fields (850 mb, 700 mb, or 500 mb) is chosen, only the wind data at the selected level is used to construct the wind field. For example, the 850 mb wind at each grid point is calculated by interpolating in time the 850 mb winds at each rawinsonde station, and then applying Equation 2-1 with the summation over the rawinsonde stations.

2.2.2 Surface Friction Velocity

The surface friction velocity, u_*, can be computed from routinely available meteorological data if the surface roughness characteristics are known. First, the sensible heat flux is calculated from an estimate of net radiation. Then u_* is determined from wind speed, surface roughness and heat flux.

The sensible heat flux, H, is estimated during daylight hours by the following equations (Maul 1980):

$$H = \alpha R + H_o \qquad (2\text{-}2)$$

$$R = 950\, \beta \sin \upsilon \qquad (2\text{-}3)$$

$$H_o = 2.4\, C - 25.5 \qquad (2\text{-}4)$$

where,

H is the sensible heat flux (Wm^{-2}),
H_o is the heat flux in the absence of solar incoming radiation (Wm^{-2}),
α is a land use constant, (~ 0.3),
R is the incoming solar radiation (Wm^{-2}),
β is a radiation reduction factor due to the presence of clouds,
υ is the solar elevation angle, and
C is the opaque cloud cover (in tenths).

Table 3 contains default values for the solar radiation reduction factor (β) due to the presence of clouds. The values of β are adapted from those used by Maul (1980).

The sine of the solar elevation angle, $\sin \upsilon$, is given by:

$$\sin \upsilon = \sin \phi \sin K_d + \cos \phi \cos K_d \cos H_A \qquad (2\text{-}5)$$

$$H_A = (\pi/12)\ (\tau - E_m) - \lambda \qquad (2\text{-}6)$$

$$\begin{aligned} E_m = {} & 12. + 0.12357 \sin (D) - 0.004289 \cos (D) \\ & + 0.153809 \sin (2D) + 0.060783 \cos (2D) \end{aligned} \qquad (2\text{-}7)$$

$$D = (d-1)\ (360./365.242)(\pi/180) \qquad (2\text{-}8)$$

$$K_D = \sin^{-1} (0.39784989 \sin (\pi\ \sigma_A/180) \qquad (2\text{-}9)$$

$$\begin{aligned} \sigma_A = {} & 279.9348 + D(180/\pi) + 1.914827 \sin (D) \\ & -0.079525 \cos (D) + 0.019938 \sin (2D) - 0.00162 \cos (2D) \end{aligned} \qquad (2\text{-}10)$$

where ϕ is the latitude (radians),
λ is the longitude (radians),
d is the Julian day, and
τ is the time of day (hours).

TABLE 3. SOLAR RADIATION REDUCTION FACTOR β

Cloud Cover (Tenths)	β
0	1.00
1	0.91
2	0.84
3	0.79
4	0.75
5	0.72
6	0.68
7	0.62
8	0.53
9	0.41
10	0.23

With the above estimate of H, the surface friction velocity, u_*, can be estimated during unstable conditions by the method described by Wang and Chen (1980):

$$u_* = \tilde{u}_* \{1 + a \ln [1 + b\, Q_o/\tilde{Q}_o]\} \tag{2-11}$$

$$\tilde{u}_* = \frac{k u_m}{\ln (z_m/z_o)} \tag{2-12}$$

$$z_m = z_{ms} - 4\, z_o \tag{2-13}$$

$$Q_o = H/(\rho\ c_p) \tag{2-14}$$

$$\tilde{Q}_o = \frac{\theta\ \tilde{u}_*^{\,3}}{k\ g\ z_m} \tag{2-15}$$

$$a = \begin{cases} 0.128 + 0.005 \ln (z_o/z_m) & z_o/z_m \leq 0.01 \\ 0.107 & z_o/z_m > 0.01 \end{cases} \tag{2-16}$$

$$b = 1.95 + 32.6\, (z_o/z_m)^{0.45} \tag{2-17}$$

where

k is the von Karman constant (0.4),

c_p is the specific heat of air at constant pressure ($996\ m^2/(s^2\ deg)$),

u_* is the surface friction velocity (m/s),

u_m is the wind speed (m/s) measured at height z_{ms} (m),
z_o is the surface roughness (m), and
ρ is the density of air (kg/m^3).

During stable conditions, u_* is determined by the following method (Venkatram 1980):

$$u_* = \frac{C_{DN}\ u_m}{2}\ [1 + C^{0.5}] \tag{2-18}$$

$$C_{DN} = \frac{k}{\ln\ (z_m/z_o)} \tag{2-19}$$

$$C = 1 - \frac{4\ u_o^2}{C_{DN} u_m^2} \qquad C \geq 0 \tag{2-20}$$

$$u_o^2 = \frac{\gamma\ z_m}{k\ A} \tag{2-21}$$

where γ and A are constants with default values of 4.7 and 1100, respectively, and C_{DN} is the neutral drag coefficient.

2.2.3 Monin-Obukhov Length

The Monin-Obukhov length, L, is defined as:

$$L \equiv -\frac{u_*^{\ 3} T_o}{g\ k\ Q_o} \tag{2-22}$$

where T_o is the observed air temperature. During unstable conditions, L is calculated directly from its definition using values of u_* and Q_o computed earlier. During stable conditions, L is given by Venkatram (1980b) as:

$$L = A\,u_*^2 \tag{2-23}$$

The constant, A, has a default value of 1100. It is the same constant that appears in Equation 2-21.

2.2.4 Mixed Layer Height

During daylight hours, solar radiation reaching the ground produces a positive (upward) flux of sensible heat which causes the growth of a well-mixed adiabatic layer. If the hourly variation of H is known, the mixed layer height, z_i, at time $\tau + 1$ can be estimated from z_i at time t in a stepwise manner (Maul 1980).

$$(z_i)_{t+1} = \left[(z_i)^2_t + \frac{2H(1+E)\Delta t}{\psi_1 \rho c_p} - \frac{2(\Delta\theta)_t (z_i)_t}{\psi_1}\right]^{1/2} + \frac{(\Delta\theta)_{t+1}}{\psi_1} \tag{2-24}$$

$$(\Delta\theta)_{t+1} = \left(\frac{2\psi_1 EH\Delta t}{\rho c_p}\right)^{1/2} \tag{2-25}$$

where

ψ_1 is the potential temperature lapse rate in the layer above z_i,

Δt is the time step (3600 s),
E is a constant (~ 0.15), and
$\Delta\theta$ is the temperature discontinuity at the top of the mixed layer.

The lapse rate, ψ_1, is determined through a layer Δz meters above the previous hour's convective mixing height. For daytime hours up to 23 GMT, the morning (12 GMT) sounding at the nearest rawinsonde station is used to calculate ψ_1. After 23 GMT, the evening (00 GMT) sounding is used. To avoid computational problems, ψ_1, is not allowed to be less than a minimum value of 0.001 °K/m.

The neutral (shear produced) boundary layer height is given by Venkatram (1980) as:

$$z_i = \frac{B\ u_*}{(f N_B)^{1/2}} \qquad (2\text{-}26)$$

where f is the Coriolis parameter,
B is a constant ($\sqrt{2}$), and
N_B is the Brunt-Vaisala frequency in the stable layer aloft.

The daytime mixing height is the maximum of the convective and mechanical values predicted by Equations 2-25 and 2-26.

In the stable boundary layer, mechanical turbulence production determines the vertical extent of dispersion. Venkatram (1980b) provides the following empirical relationship to estimate z_i during stable conditions.

$$z_i = N\ u_*^{3/2} \qquad (2\text{-}27)$$

where N is a constant with a default value of 2400.

2.2.5 Convective Velocity Scale

During convective conditions, turbulence is generated primarily by the sensible heat flux originating from the ground. The appropriate velocity scale during these conditions is the convective velocity, w_*.

$$w_* \equiv \left(\frac{g}{T_o} Q_o z_i\right)^{1/3} \qquad (2\text{-}28)$$

The convective velocity can be calculated directly from its definition, since Q_o and z_i were obtained by Equations 2-14 and 2-24, respectively.

2.2.6 Atmospheric Stability Class

The stability class at each grid point is estimated according to the Turner (1964) method using the solar radiation and reported cloud data at the nearest surface station and the interpolated surface wind speed at the grid point. A radiation index, RI, is computed based upon the value of the solar elevation angle at the nearest surface station (Table 4 (a)). The radiation index is an indication of potential solar radiation and varies from a value of 1 for $\nu \leq 15°$ to 4 for $\nu > 60°$. The effects of cloud cover in reducing radiation is included in the daytime insolation class, IC, computed from RI, opaque cloud cover, and ceiling height observations at the nearest surface station (Table 4 (b)). The daytime stability class is then determined from IC and the surface wind speed at the grid point according to Table 5. Nighttime stability is determined by surface wind speed and opaque cloud cover. Overcast conditions (10/10 cloud cover) result in neutral (D) stability for both day and night.

T4

T5

TABLE 4. DAYTIME SOLAR INSOLATION CLASSIFICATION SCHEME

(a) Radiation Index as a Function of Solar Elevation Angle

Solar Elevation Angle, υ	Radiation Index, RI
$0° < \upsilon \leq 15°$	1
$15° < \upsilon \leq 25°$	2
$35° < \upsilon \leq 60°$	3
$60° < \upsilon$	4

(b) Calculation of Daytime Solar Insolation Class

Cloud Cover, CC	Ceiling HT, CH (ft)	Daytime Insolation Class, IC
$CC \leq 5/10$	-	RI
$5/10 < CC < 10/10$	$CH < 7{,}000$	RI-2*
	$7{,}000 \leq CH < 16{,}000$	RI-1*
	$16{,}000 \leq CH$	RI
$CC = 10/10$	$CH < 7{,}000$	0
	$7{,}000 \leq CH < 16{,}000$	RI-2*
	$16{,}000 \leq CH$	RI-1*

---

*IC is not allowed to be reduced to less than one (only exception is with CC = 10/10, CH < 7,000 ft).

TABLE 5. STABILITY CLASSIFICATION CRITERIA

Surface wind speed (knots)	Daytime Insolation Class, IC					Nighttime	
	Strong (4)	Moderate (3)	Slight (2)	Weak (1)	Overcast (0)	5/10–9/10 Cloud	<5/10 Cloud
≤ 1	A	A	B	C	D	F	F
2	A	B	B	C	D	F	F
3	A	B	B	C	D	F	F
4	A	B	C	D	D	E	F
5	A	B	C	D	D	E	F
6	B	B	C	D	D	E	F
7	B	B	C	D	D	D	E
8	B	C	C	D	D	D	E
9	B	C	C	D	D	D	E
10	C	C	D	D	D	D	E
11	C	C	D	D	D	D	D
≥ 12	C	D	D	D	D	D	D

2.3 MESOPUFF II Dispersion Model

2.3.1 Basic Gaussian Puff Equations

MESOPUFF II is a Gaussian variable-trajectory puff superposition model designed to account for the spatial and temporal variation in advection, diffusion, transformation, and removal mechanisms on regional scales. A continuous plume is simulated as a series of discrete puffs. The trajectory of each puff is determined independently of preceding or succeeding puffs. Each puff is subject to space- and time-varying wet removal, dry deposition, and chemical transformation. The governing equation for a horizontally symmetric puff with a Gaussian distribution is:

$$C(s) = \frac{Q(s)}{2\pi\sigma_y^2(s)} g(s) \exp\left[-\frac{r^2(s)}{2\sigma_y^2(s)}\right] \qquad (2\text{-}29)$$

$$g(s) = \frac{2}{\sqrt{2\pi}\,\sigma_z} \sum_{n=-\infty}^{\infty} \exp\left[-\frac{1}{2}\frac{(H_e + 2nz_i)^2}{\sigma_z^2(s)}\right] \qquad (2\text{-}30)$$

where,

$C(s)$ is the ground-level concentration,

s is the distance travelled by the puff,

$Q(s)$ is the mass of pollutant in the puff,

$\sigma_y(s)$ is the standard deviation of the Gaussian distribution in the horizontal,

$\sigma_z(s)$ is the standard deviation of the Gaussian distribution in the vertical,

$r(s)$ is the radial distance from the puff center,

z_i is the mixed-layer height, and

H_e is the effective height of the puff center.

The infinite series in Equation 2-30 converges rapidly for values of $T = (\sigma_z/z_i)^2 < 0.6$; usually fewer than 3 or 4 terms are required for convergence. For $T > 0.6$, Equation 2-30 is expressed in an equivalent from using a Fourier series that converges quickly for large values of T (Schulman and Scire 1980). The vertical term, g(s), reduces to the uniformly mixed limit of $1/z_i$ for $\sigma_z/z_i \geq 1.6$. In general, puffs within the daytime mixed-layer satisfy this criterion about an hour or two after release. The user is permitted to specify an initial Gaussian vertical distribution (Eq. 2-30) or an immediately uniform vertical distribution ($g(s) = 1/z_i$) for newly released puffs. MESOPUFF II allows the effect of dry deposition to be treated with the conventional source depletion method or a more realistic surface depletion (3-layer) model. These options are described in more detail in Section 2.3.5.

The dispersion parameters, σ_y and σ_z, are calculated for puff travel distances up to 100 kilometers with plume growth functions fitted to the curves of Turner (1970). These functions are of the form:

$$\sigma = a\, x^b \tag{2-31}$$

where

a,b are stability-dependent coefficients, and
x is the total distance travelled.

Equation 2-31 is valid, however, only if the stability class does not change during the puff's travel. Stability class variations are allowed for by using a virtual distance, x_v, instead of x (Ludwig et al. 1977).

$$(\sigma_y)_t = a_y \left[(x_v)_y + \delta x\right]^{b_y} \tag{2-32}$$

$$(\sigma_z)_t = a_z \left[(x_v)_z + \delta x\right]^{b_z} \tag{2-33}$$

$$(x_v)_y = \left[\frac{(\sigma_y)_{t-1}}{a_y}\right]^{1/b_y} \tag{2-34}$$

$$(x_v)_z = \left[\frac{(\sigma_z)_{t-1}}{a_z}\right]^{1/b_z} \tag{2-35}$$

where

$(\sigma_y)_{t-1}$, $(\sigma_z)_{t-1}$ are the values of σ_y, σ_z (m) at the previous time step, and

δx is the incremental distance travelled (m).

The values of a_y, b_y, a_z, and b_z in Equations 2-32 through 2-35 are those for the current stability class. Thus, x_v represents the distance the puff would have travelled to reach its size at time t-1 if current stability conditions were in effect throughout its travel. The incremental distance, δx, is evaluated from the midpoint of the previous time step's trajectory to the midpoint of the current trajectory. Table 6 contains the default values of the coefficients a_y, b_y a_z, b_z stored in MESOPUFF II.

The time-dependent puff growth equation used for distances greater than 100 kilometers are those given by Heffter (1965):

TABLE 6. PUFF GROWTH RATE COEFFICIENTS a_y, b_y, a_z, b_z

Stability Class	a_y	b_y	a_z	b_z
A	0.36	0.9	0.00023	2.10
B	0.25	0.9	0.058	1.09
C	0.19	0.9	0.11	0.91
D	0.13	0.9	0.57	0.58
E	0.096	0.9	0.85	0.47
F	0.063	0.9	0.77	0.42

$$(\sigma_y)_t = (\sigma_y)_{t-1} + 0.5\ \delta t \quad (2\text{-}36)$$

$$(\sigma_z)_t = (\sigma_z)_{t-1} + \frac{a_{zt}\ \delta t}{\sqrt{t}} \quad (2\text{-}37)$$

$$a_{zt} = 0.5\ (2K_z)^{1/2} \quad (2\text{-}38)$$

where

δt in the incremental time (s),
t in the total age of the puff (s), and
K_z is the vertical eddy diffusivity (m^2/s).

The default values of K_z (and a_{zt}) are contained in Table 7. The option is provided in MESOPUFF II for the user to override any of the default dispersion coefficient parameters, including the crossover distance to time dependent growth (Equations 2-36 to 2-38).

MESOPUFF II allows three options for determining growth rates for puffs above the boundary layer: (1) E stability rates, (2) F stability rates, or (3) boundary layer stability rates. The default instructions are to use the E stability growth curves for puffs above the boundary layer (see variable JSUP in MESOPUFF II inputs).

2.3.2 Grid Systems

A Cartesian coordinate reference frame is employed in MESOPAC II and MESOPUFF II. Three nested grid systems are used: a meteorological grid, a computational grid, and a sampling grid. The size of each grid is limited to 40 x 40 horizontal grid indices.

The meteorological grid is the system of grid points at which meteorological parameters (wind components, mixing height, etc.) are

TABLE 7. VERTICAL DIFFUSIVITY AND PUFF GROWTH RATE COEFFICIENT a_{zt}

Stability Class	K_z (m^2/s)	a_{zt}
A	50	5.0
B	30	3.873
C	15	2.739
D	7	1.871
E	3	1.225
F	1	0.707

defined. The meteorological grid is determined by inputs to MESOPAC II. It is the basic reference frame for all spatial input data to both MESOPAC II and MESOPUFF II (e.g., coordinates of meteorological stations, sources, and nongridded receptors). The southwest corner of the meteorological grid defines the point (x,y) = (1.0,1.0).

The computational grid determines the computational area for a MESOPUFF II run, i.e., puffs are advected and tracked only while within the computational grid. When the center of a puff is transported outside the bounds of the computational grid, this puff is eliminated in the next sampling step. Thus, all sources and receptors must be located within the computational grid. To avoid possible boundary effects, receptors should be located away from the edges of the computational grid.

The sampling grid defines the set of gridded receptors. It must be equal to or a subset of the computational grid. Its resolution is a multiple of the resolution of the computational (and meteorological) grid. The range and resolution (grid spacing) of the sampling grid must be defined as to not exceed a maximum size of 40 x 40. It should be noted that non-gridded (discrete) receptors are not limited to be within the sampling grid; they may be placed anywhere within the computational grid. Computational savings will be realized if the sampling grid is limited only to areas of interest. The sampling grid may be eliminated entirely if sufficient coverage can be obtained with non-gridded receptors (see variable LVSAMP in MESOPUFF II inputs).

Figure 3 illustrates one possible arrangement for the three grids. The computational grid is a 10 x 8 grid within the 11 x 9 meteorological grid. The sampling grid extends from coordinates (3.0,2.0) to (10.0,7.0) and has a resolution twice that of the other grids. In this example, the sampling grid size is 15 x 11.

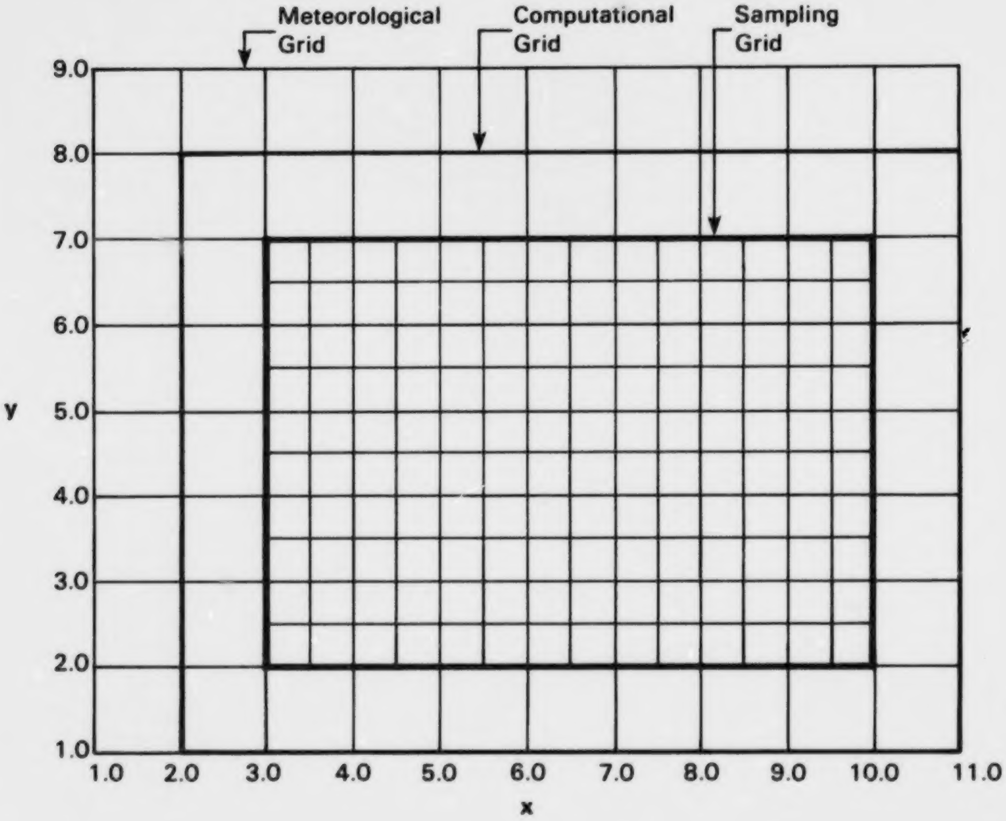
Meteorological Grid
Computational Grid
Sampling Grid
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
y
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
x

Figure 3 Sample Meteorological, Computational and Sampling Grids

8304030

2.3.3 Plume Rise

The plume rise, Δh, of each puff is computed by the Briggs (1975) plume rise equations for final rise. For unstable and neutral conditions when the puff center does not rise above the top of the boundary layer, Δh is given by:

$$\Delta h = 1.6\, F^{1/3}\, X_F^{2/3} / u_m \qquad (2\text{-}39)$$

$$X_F = \begin{cases} (3.5)(14\, F^{5/8}) & F \leq 55\ m^4/s^3 \\ (3.5)(34.49\, F^{2/5}) & F > 55\ m^4/s^3 \end{cases} \qquad (2\text{-}40)$$

where, F is the initial stack plume buoyancy flux (m^4/s^3),

X_F is the distance to final plume rise (m), and

u_m is the larger of boundary layer (lower level) wind speed (m/s) or 1.37 m/s.

The ambient temperature at the closest surface meteorological station to the source is used in the computation of the buoyancy flux.

If the puff penetrates into the elevated stable layer above the boundary layer, the Briggs (1975) partial penetration plume rise equation is used to provide a second estimate of plume rise. The actual plume rise is taken as the minimum of the two plume rise estimates.

$$\Delta h = \text{minimum} \begin{cases} 1.6\, F^{1/3}\, X_F^{2/3} / u_m \\ [1.8\, z_b^3 + 18.75\, F/(u_m S)]^{1/3} \end{cases} \qquad (2\text{-}41)$$

where z_b is the distance from the stack top, h_s, to the top of the boundary layer, z_i, and

S is the stability parameter $(g/T)(\partial\theta/\partial z)$.

A potential temperature gradient, $\partial\theta/\partial z$, of 0.0137 K/m is assumed, yielding a value of S of $4.63 \times 10^{-4}\ s^{-1}$.

For stable conditions, Δh is given by:

$$\Delta h = \begin{cases} 2.6F^{1/3} / (uS)^{1/3} & u \geq 1.37 \text{ m/s} \\ 5.0F^{1/4} / S^{3/8} & u < 1.37 \text{ m/s} \end{cases} \qquad (2\text{-}42)$$

2.3.4 Puff Trajectory Function

Puffs are advected during each sampling step according to a Lagrangian trajectory function. The change in position of a puff center over a time interval Δt is:

$$x(t+\Delta t) = x(t) + \Delta x = \int_{t}^{t+\Delta t} u[t'; x(t'), y(t')]\, dt' \qquad (2\text{-}43)$$

$$y(t+\Delta t) = y(t) + \Delta y = \int_{t}^{t+\Delta t} v[t'; x(t'), y(t')]\, dt' \qquad (2\text{-}44)$$

where, $[x(t), y(t)]$ and $[x(t+\Delta t), y(t+\Delta t)]$ are the puff center coordinates at the time t and $t + \Delta t$, respectively; Δx, Δy are the incremental x and y distances travelled by the puff; and u, v are the easterly and northerly components of the wind. The integrals in Equations (2-43) and (2-44) are approximated by a two-step bilinear interpolation in space and time. The coordinates of a puff center at time $t + \Delta t$ are found by evaluating the vector average of two advection increments. Figure 4 illustrates the advection algorithm. The first increment is evaluated by assuming the wind components at $[x(t),y(t)]$ are constant for the advection interval Δt. Thus,

$$x_1 = x(t) + (\Delta x)_1 \qquad (2\text{-}45)$$

$$y_1 = y(t) + (\Delta y)_1 \qquad (2\text{-}46)$$

$$(\Delta x)_1 = u[t;x(t),y(t)]\, \Delta t \qquad (2\text{-}47)$$

$$(\Delta y)_1 = v[t;x(t),y(t)]\, \Delta t \qquad (2\text{-}48)$$

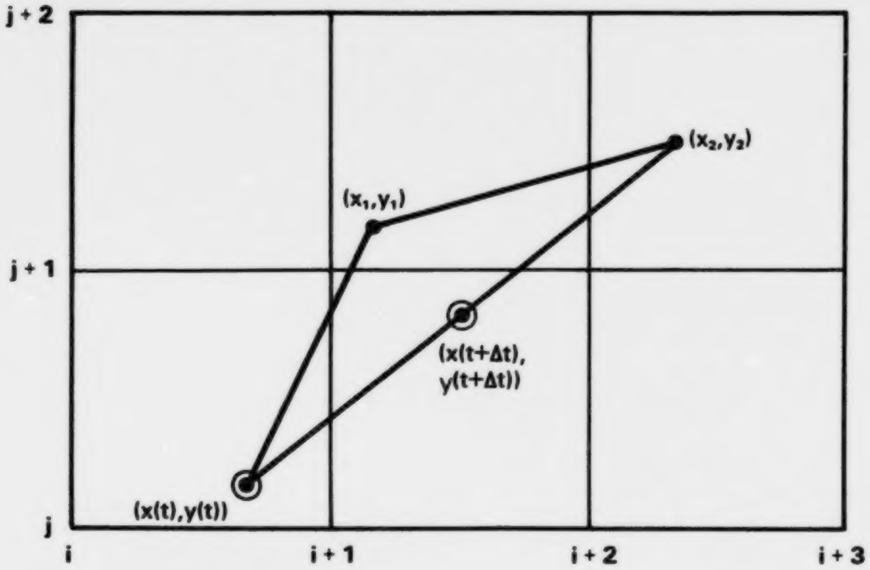
j + 2
(x₂,y₂)
(x₁,y₁)
j + 1
(x(t+Δt),
y(t+Δt))
(x(t),y(t))
j
i
i + 1
i + 2
i + 3

Figure 4 Calculation of the Trajectory of a Puff Centerpoint

However, because the wind changes in both space and time, a second increment is calculated using (x_1, y_1) as the beginning of the trajectory and the wind components for time $t + \Delta t$ at (x_1, y_1). Assuming these wind components are constant for a time interval Δt, the endpoint of this increment becomes (x_2, y_2).

$$x_2 = x_1 + (\Delta x)_2 \tag{2-49}$$

$$y_2 = y_1 + (\Delta y)_2 \tag{2-50}$$

$$(\Delta x)_2 = u[t + \Delta t; x_1, y_1] \Delta t \tag{2-51}$$

$$(\Delta y)_2 = v[t + \Delta t; x_1, y_1] \Delta t \tag{2-52}$$

Weighting each increment equally, the new puff position $[x(t + \Delta t), y(t + \Delta t)]$ is the midpoint of the line from $[x(t), y(t)]$ to (x_2, y_2). Thus, the winds at two points in space and in time are used to evaluate the trajectory of the puff.

$$x(t + \Delta t) = x(t) + 0.5 \, [(\Delta x)_1 + (\Delta x)_2] \tag{2-53}$$

$$y(t + \Delta t) = y(t) + 0.5 \, [(\Delta y)_1 + (\Delta y)_2] \tag{2-54}$$

The wind components u, v are defined only at the grid points at hourly intervals. The effective wind components at the puff center at time t are obtained by the following bilinear interpolation scheme:

$$\begin{aligned} u[t;x(t),y(t)] = {} & t_1 \, \delta y_2 \, \delta x_2 \, u[t_n; i, j] + t_2 \delta y_2 \delta x_2 \, u[t_{n+1}, i, j] \\ & + t_1 \, \delta y_2 \, \delta x_1 \, u \, [t_n; i + 1, j] + t_2 \delta y_2 \, \delta x_1 \, u \, [t_{n+1}, i + 1, j] \\ & + t_1 \, \delta y_2 \, \delta x_2, \, u \, [t_n; i, j+1] + t_2 \, \delta y_1 \, \delta x_2 \, u \, [t_{n+1}, i, j+1] \\ & + t_1 \, \delta y_1 \, \delta x_1 \, u \, [t_n; i+1, j+1] + t_2 \, \delta y_1 \, \delta x_1 \, u \, [t_{n+1}; i+1, j+1] \end{aligned} \tag{2-55}$$

$$\text{where, } t_2 = \frac{t - t_n}{t_{n+1} - t_n} \qquad t_n \leq t \leq t_{n+1} \tag{2-56}$$

$$t_1 = 1.0 - t_2 \tag{2-57}$$

and t_n, t_{n+1} are the times closest to time t at which the wind field is defined. The variables δx_1, δx_2, δy_1, δy_2 are the fractional x and y distances (in grid units) from the four surrounding grid points to the puff center as illustrated in Figure 5. The northerly wind component, $v[t, x(t), y(t)]$ is computed in an identical manner.

2.3.5 Dry Deposition - Three-Layer Model

The rate at which pollutants are deposited on the surface depends upon many factors: the characteristics of the pollutant, the underlying surface, and atmospheric conditions. The variability of surface and atmospheric conditions in space and time can cause significant variations in dry deposition rates. MESOPUFF II accounts for the spatial and temporal variations of deposition rates by the use of a resistance model. The deposition velocity, defined as the ratio of the vertical pollutant flux at a reference height to the concentration at that height, is expressed as the inverse of a sum of resistances to pollutant transfer through the atmosphere to the surface.

$$v_d = (r_a + r_s + r_c)^{-1} \tag{2-58}$$

where v_d is the deposition velocity (m/s),
r_a is the aerodynamic resistance[1] (s/m),
r_s is the surface resistance[1] (s/m), and
r_c is the canopy resistance[1] (s/m).

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[1] It should be noted that MESOPUFF II uses MKS units. Therefore, resistances that are commonly reported in s/cm must be converted to s/m for input to the model.

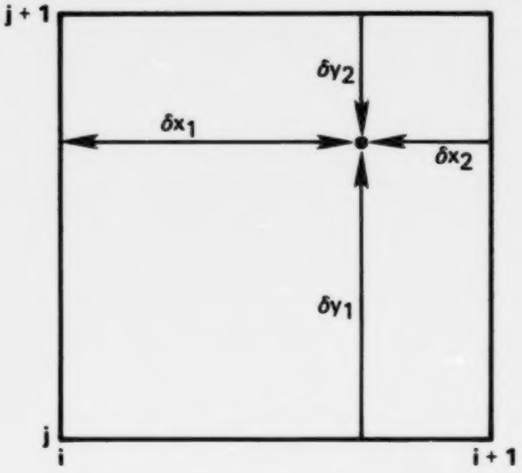
j + 1
δy2
δx1
δx2
δy1
j
i
i + 1

Figure 5   Bilinear Interpolation of Wind Components

The aerodynamic resistance, r_a, is given by Wesely and Hicks (1977) as:

$$r_a = (k\ u_*)^{-1}\ [\ln(z_s/z_o) - \psi_H] \tag{2-59}$$

$$\psi_H = \begin{cases} -5z_s/L & 0 < z_s/L < 1 \\ \exp\ [0.598 + 0.39\ \ln\ (-z_s/L) - 0.090\ \{\ln(-z_s/L)\}^2] & -1 < z_s/L < 0 \end{cases} \tag{2-60}$$

where z_s is the reference height (10 meters),

z_o is the surface roughness length (m),

u_* is the friction velocity (m/s),

ψ_H is a function accounting for stability effects, and

k is the von Karman constant.

The surface resistance, r_s, can be expressed (Wesely and Hicks 1977) as:

$$r_s = (k\ u_*)^{-1}\ k\ B^{-1} \tag{2-61}$$

where B^{-1} is the surface transfer coefficient. For SO_2, NO_x, and HNO_3, kB^{-1} is assigned a default value of 2.6. A constant value of r_s for the $SO_4^=$ and NO_3^- aerosols of 1000 s/m is assumed.

Table 8 contains the default canopy resistances for SO_2 as a function of land use and stability class for summertime conditions (Shieh et al. 1979). The roughness length associated with each land use category is also presented. Based upon its high solubility and reactivity, r_c for HNO_3 is assumed to be zero. The default canopy resistance for NO_x is 1500

TABLE 8. SUMMERTIME SO_2 CANOPY RESISTANCES (s/m) AS A FUNCTION OF LAND USE TYPE AND STABILITY CLASS

Category	Land Use Type	z_o (m)	A,B,C	D	E	F
1	cropland and pasture	0.20	100.	300.	1000.	0.
2	cropland, woodland and grazing land	0.30	100.	300.	1000.	0.
3	irrigated crops	0.05	100.	300.	1000.	0.
4	grazed forest and woodland	0.90	100.	300.	1000.	0.
5	ungrazed forest and woodland	1.00	100.	300.	1000.	0.
6	subhumid grassland and semiarid grazing land	0.10	100.	300.	1000.	0.
7	open woodland grazed	0.20	100.	300.	1000.	0.
8	desert shrubland	0.30	200.	500.	1000.	1000.
9	swamp	0.20	50.	75.	100.	0.
10	marshland	0.50	75.	300.	1000.	0.
11	metropolitan city	1.00	1000.	1000.	1000.	0.
12	lake or ocean	10^{-4}	0.	0.	0.	0.

Source: Shieh, Wesely, and Hicks (1979).

s/m. Uptake of the $SO_4^=$ and NO_3^- aerosols by plant stomata is less relevant; therefore, total resistance for $SO_4^=$ and NO_3^- is determined by r_a and r_s (i.e., $r_c = 0$).

With knowledge of the concentration and the deposition velocity, the pollutant flux is determined. MESOPUFF II has two options for treating the removal of pollutant from the puff. The first option is the commonly used source depletion approximation. This method assumes that material deposited is removed from the full depth of the puff. The change in mass is:

$$Q(t+1) = Q(t) \exp \frac{-v_d \Delta t}{\Delta s} \int_{s}^{s + \Delta s} g(s')\, ds' \qquad (2\text{-}62)$$

Where $Q(t)$, $Q(t+1)$ is the mass (g) of pollutant in the puff at the beginning and end of the time step,

s, $s + \Delta s$ is the position of the puff at the beginning and end of the time step, and

$g(s)$ is the vertical term of the Gaussian puff equation as given by Equation 2-30. For a puff uniformly mixed in the vertical, $g(s) = 1/z_i$.

The source depletion model effectively enhances the rate of vertical diffusion of the pollutant because mass removed at the surface is immediately replaced with material from above. However, in the atmosphere, the rate of deposition can be limited (mostly during stable conditions) by the rate of pollutant mass transfer through the boundary layer to the surface layer. This overall boundary layer resistance is not included in the aerodynamic resistance. To account for the effect of boundary layer mixing, MESOPUFF II has the option to treat puffs that have become vertically well-mixed with a 3-layer model (see Figure 6). The surface layer is a shallow layer (10 m) next to the ground that rapidly adjusts to changes in surface conditions. Pollutants in the middle layer are uniformly

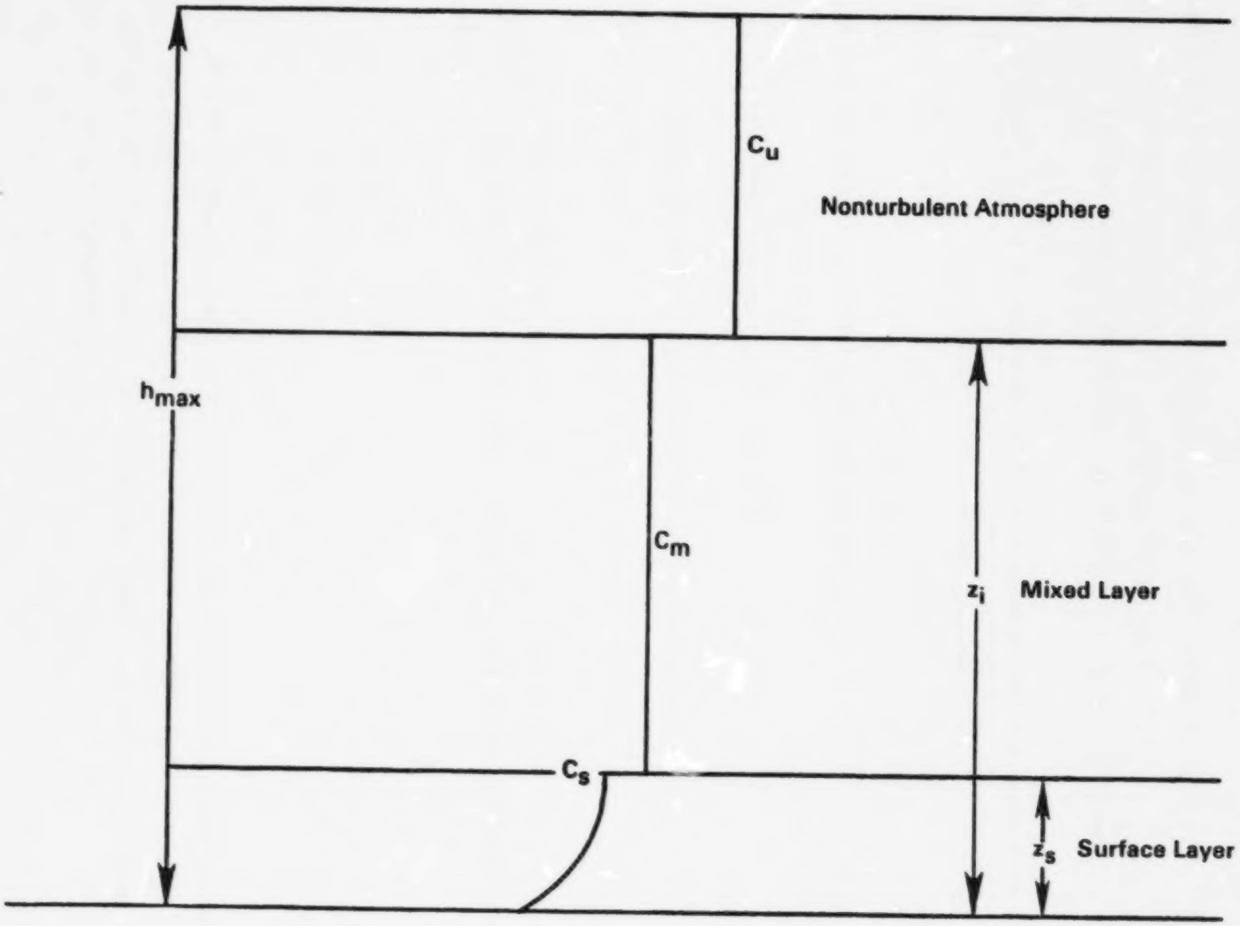
8106120
C_u
Nonturbulent Atmosphere
h_{max}
C_m
z_i
Mixed Layer
C_s
z_s
Surface Layer

Figure 6   Optional Three Layer System Used in MESOPUFF II

mixed up to the top of the current boundary layer. The upper layer consists of pollutant material above the boundary layer dispersed upward during previous turbulent activity. The pollutant flux into the surface layer is:

$$\text{Flux} = \kappa \, (C_m - C_s) \, / \, (z_i - z_s) = v_d \, C_s \tag{2-63}$$

where κ is an overall boundary layer eddy diffusivity (m^2/s),

C_m is the concentration in the middle layer, and
C_s is the concentration at the top of the surface layer.

During stable conditions, κ is given by Brost and Wyngaard (1978) as:

$$\kappa = k_1 \, u_* \, z_i \tag{2-64}$$

and during neutral or unstable conditions κ is:

$$\kappa = \text{Maximum} \, \{k_1 \, u_* \, z_i, \; k_2 \, w_* \, z_i\} \tag{2-65}$$

The constants k_1 and k_2 have default values of 0.01 and 0.1, respectively.

The term $v_d \, C_s$ can be written as $v_d' \, C_m$, where v_d' is an effective deposition velocity taking into account boundary layer mass transfer.

$$v_d' = \frac{\kappa \, v_d}{\kappa + v_d (z_i - z_s)} \tag{2-66}$$

In the 3-layer model, only material in the surface layer is available for deposition at the surface. The effective deposition velocity, v_d' is used in Equation 2-62 to evaluate the change in pollutant mass in the puff due to dry deposition.

2.3.6 Chemical Transformations

The chemical processes modeled in MESOPUFF II are the conversion of sulfur dioxide (SO_2) to sulfate ($SO_4^=$) and the conversion of nitrogen oxide ($NO_x = NO + NO_2$) to nitrate aerosol (NO_3^-). The formation of nitrate aerosol involves both photochemical reactions and chemical equilibrium considerations. NO_x is oxidized largely photochemically to gaseous nitric acid (HNO_3) and organic nitrate ($RONO_2$) such as peroxyacetylnitrate (PAN). In the presence of ammonia, a chemical equilibrium is established between gaseous HNO_3, gaseous NH_3, and the ammonium nitrate aerosol:

$$HNO_3\ (g) + NH_3\ (g) \rightleftarrows NH_4NO_3\ (aq) \qquad (2\text{-}67)$$

The equilibrium constant for this reaction is strongly dependent on relative humidity and temperature (Stelson and Seinfeld 1982). The organic nitrates formed from NO_x are not believed to form fine particulate aerosols.

Transformation rate expressions were developed for use in MESOPUFF II by statistically analyzing hourly transformation rates produced by a photochemical box model. The model employed the RHC/NO_x/SO_x chemical mechanisms of Atkinson et al. (1982). Plume SO_x/NO_x dispersing into background air containing ozone and reactive hydrocarbons (RHC) was simulated over a wide range of conditions representing different solar radiation intensities, temperatures, dispersion conditions, background ozone and RHC levels, plume NO_x concentrations and emissions times. The following equations represent curve fits to the hourly (daytime) conversion rates predicted by the photochemical model:

$$k_1 = 36\ R^{0.55}\ [O_3]^{0.71}\ S^{-1.29} + 3 \times 10^{-8}\ RH^4 \qquad (2\text{-}68)$$

$$k_2 = 1206\ [O_3]^{1.5}\ S^{-1.41}\ [NO_x]^{-0.33} \qquad (2\text{-}69)$$

$$k_3 = 1261\ [O_3]^{1.45}\ S^{-1.34}\ [NO_x]^{-0.12} \qquad (2\text{-}70)$$

where k_1 is the SO_2 to $SO_4^=$ transformation rate (percent per hour),

k_2 is the NO_x to HNO_3 + PAN transformation rate (percent per hour),

k_3 is the NO_x to HNO_3 (only) transformation rate (percent per hour),

R is the total solar radiation (kw/m^2),

$[O_3]$ is the background ozone concentration (ppm),

S is a stability index ranging from 2 to 6 (PGT class A and B=2, C=3, D=4, E=5, F=6),

RH is the relative humidity (percent), and

$[NO_x]$ is the NO_x concentration (ppm).

An empirically determined aqueous phase SO_2 conversion term (3×10^{-8} RH^4) is included in the SO_2 to $SO_4^=$ transformation equation. The aqueous phase term has a minimum value of 0.2% per hour. Constant transformation rates of 0.2 and 2% per hour for SO_2 and NO_x, respectively, are used as default values for nighttime periods.

The model provides three options for the specification of background ozone concentrations: (1) hourly ozone data from a network of stations may be input; (2) a single background ozone concentration may be specified; or, (3) the default value of 80 ppb may be used. The background ammonia concentration required for the $HNO_3/NH_3/NH_4NO_3$ equilibrium calculation may be specified by the user or the default value of 10 ppb is used.

The parameterized NO_x oxidation rate depends on the NO_x concentration. In situations where puffs overlap, it would be incorrect to calculate the NO_x oxidation rate based solely on the puff NO_x concentration. Similarly, the nitrate equilibrium should not assume that all the ambient NH_3 is available for one puff. Therefore, the total (local average) $SO_4^=$, NO_x, and TNO_3 (total nitrate = HNO_3 + NO_3^-) concentrations due to all puffs and the available ammonia (total ammonia minus sulfate) are computed. First, the average puff concentration, C, within ± 1.5 σ_y and ± 1.5 σ_z of the puff center is calculated for each puff. For an elevated Gaussian puff, $\overline{C}$ (assuming no ground reflection) is:

$$\overline{C} = \frac{0.38\ Q}{(2\ \pi)^{3/2}\ \sigma_y^2\ \sigma_z} \qquad (2\text{-}71)$$

For a puff uniformly mixed in the vertical, $\overline{C}$ is:

$$\overline{C} = \frac{0.52\ Q}{(2\ \pi)\ \sigma_y^2\ z_i} \qquad (2\text{-}72)$$

The total local average concentration is the puff's own contribution plus that of nearby puffs (within 1.5 σ_y of the puff center). Average concentrations are computed separately for puffs within the mixed layer and for those above the mixed layer.

Although the use of Equations (2-68) through (2-70) are recommended, several other alternatives are provided in MESOPUFF II. The model allows optional user-specification of hourly transformation rates for k_1, k_2, and k_3 (three arrays of 24 values each), or the following alternative rate expressions for the SO_2 oxidation rate.

Gillani et al. (1981):

$$k_1 = 0.03\ R\ h\ [O_3] \qquad (2\text{-}73)$$

where h is the plume depth (m) taken as the minimum of 3 σ_z or z_i, R is solar radiation (kw/m^2).

Henry and Hidy (1982) - (based on St. Louis data):

$$k_1 = 34.\ [O_3] \qquad (2\text{-}74)$$

Henry and Hidy (1981) - (based on Los Angeles data):

$$k_1 = 85.\ [O_3] \qquad (2\text{-}75)$$

2.3.7 Wet Removal

Numerous studies (e.g., Slinn et al. 1978, Scott 1978, 1981) have shown that precipitation scavenging in an efficient removal mechanism, especially for particulate pollutants such as $SO_4^=$. During precipitation events, wet removal can easily dominate dry deposition in pollutant removal. MESOPUFF II uses the following simple parameterization of wet removal processes:

$$Q(t + 1) = Q(t) \exp [\, - \Lambda \,\Delta t] \qquad (2\text{-}76)$$

where $Q(t)$, $Q(t + 1)$ is the mass (g) of pollutant in the puff at the beginning and end of the time step,
Λ is the scavenging ratio (s^{-1}), and
Δ t is the time step (s).

Maul (1980) expresses Λ as:

$$\Lambda = \lambda \ (R/R_1) \qquad (2\text{-}77)$$

where R is the rainfall rate (mm/hr),
R_1 is a reference rainfall rate of 1 mm/hr, and
λ is a scavenging coefficient (s^{-1}).

Table 9 contains the default values of the scavenging coefficient used in MESOPUFF II. The rainfall rate used in Equation 2-77 in that observed at the closest surface (TD9657) station to the puff center.

T9

A precipitation code determined from the surface (CD144) observations of precipitation type/intensity is used to determine if the value of λ for liquid or frozen precipitation is most appropriate. Precipitation observations are converted to precipitation codes as shown in Table 10. The

T10

TABLE 9. DEFAULT VALUES OF THE SCAVENGING COEFFICIENT, λ (s^{-1})

POLLUTANT	LIQUID PRECIPITATION	FROZEN PRECIPITATION
SO_2	3×10^{-5}	0.0
$SO_4^=$	1×10^{-4}	3×10^{-5}
NO_x	0.0	0.0
HNO_3	6×10^{-5}	0.0
NO_3^-	1×10^{-4}	3×10^{-5}

TABLE 10. CONVERSION OF REPORTED PRECIPITATION TYPE/INTENSITY TO PRECIPITATION CODES

Liquid Precipitation

Precipitation Code	Type	Intensity
1	Rain	Light
2	Rain	Moderate
3	Rain	Heavy
4	Rain Showers	Light
5	Rain Showers	Moderate
6	Rain Showers	Heavy
7	Freezing Rain	Light
8	Freezing Rain	Moderate
9	Freezing Rain	Heavy
10	Not Used	-
11	Not Used	-
12	Not Used	-
13	Drizzle	Light
14	Drizzle	Moderate
15	Drizzle	Heavy
16	Freezing Drizzle	Light
17	Freezing Drizzle	Moderate
18	Freezing Drizzle	Heavy

Frozen Precipitation

Precipitation Code	Type	Intensity
19	Snow	Light
20	Snow	Moderate
21	Snow	Heavy
22	Snow Pellets	Light
23	Snow Pellets	Moderate
24	Snow Pellets	Heavy
25	Not Used	-
26	Ice Crystals	*
27	Not Used	-
28	Snow Showers	Light
29	Snow Showers	Moderate
30	Snow Showers	Heavy
31	Not Used	-
32	Not Used	-
33	Not Used	-
34	Snow Grains	Light
35	Snow Grains	Moderate
36	Snow Grains	Heavy
37	Ice Pellets	Light
38	Ice Pellets	Moderate
39	Ice Pellets	Heavy
40	Not Used	-
41	Hail	*
42	Not Used	-
43	Not Used	-
44	Small Hail	*
45	Not Used	-

---

* Intensity not currently reported for ice crystals, hail and small hail.

liquid precipitation values of λ are used for precipitation codes 1-18; the frozen precipitation values are used for codes 19-45.

2.3.8 Puff Sampling Function

MESOPUFF II simulates a continuous plume with a series of discrete puffs. The total concentration is calculated by summing the contributions of each nearby puff (within 3 σ_y of the receptor). The contribution of a single puff integrated over the distance of puff travel, Δs, during the sampling step is:

$$C(r,s) = \frac{1}{\Delta s} \int_{s}^{s+\Delta s} \frac{Q(s)\, g(s)}{2\pi\, \sigma_y^2 (s)} \exp \left[\frac{-r^2 (s)}{2\sigma_y^2 (s)} \right] ds \tag{2-78}$$

where g(s) is the vertical term given by Equation 2-30. If it is assumed that the most significant s dependence during the sampling step is in the r(s) and Q(s) terms, this integral can be evaluated and expressed as:

$$C(r,s) = \frac{g(s)}{2\pi\, \sigma_y^{\,2}} \left[Q_o I_1 + (Q_n - Q_o)\, I_2 \right] \tag{2-79}$$

$$I_1 = \sqrt{\frac{\pi}{2a}}\ \exp \left[1/2\ (b^2/a - c) \right] \_ \left\{ \text{erf} \left(\frac{a+b}{\sqrt{2a}} \right) - \text{erf} \left(\frac{b}{\sqrt{2a}} \right)] \right\} \tag{2-80}$$

$$I_2 = \frac{-b}{a} I_1 + \frac{1}{a}\ \exp \left[1/2\ (b^2/a - c) \right] \left\{ \exp \left[-\frac{1}{2}\, b^2/a \right] - \exp \left[-\frac{1}{2}\ (a+2b+b^2/a) \right] \right\} \tag{2-81}$$

$$a = (\Delta x^2 + \Delta y^2) / \sigma_y^{\,2} \tag{2-82}$$

$$b = [\Delta x (x_t - x_r) + \Delta y\ (y_t - y_r)] / \sigma_y^2 \tag{2-83}$$

$$c = [(x_t - x_r)^2 + (y_t - y_r)^2] / \sigma_y^{\,2} \tag{2-84}$$

where Q_o, Q_n is the pollutant mass (g) in the puff at the beginning and end of the time step,

(x_r, y_r) are the receptor coordinates (m),

(x_t, y_t) are the puff coordinates (m) at the beginning of the sampling step, and,

Δx, Δy are the incremental x and y distances travelled by the puff during the sampling step.

The exponential variation of Q due to removal and chemical transformation processes is expressed with a linear function over the sampling interval. The puff trajectory segment is assumed to be a straight line. More details of the sampling function derivation are contained in Scire et al. (1983).

2.3.9 Urban Plumes

Emissions of SO_2 and NO_x and their transformation to particulate sulfate and nitrate within and downwind of urban regions can significantly influence regional scale air quality. MESOPUFF II offers the capability to model the large number of stationary and mobile sources within an urban area as one or more area sources. It is assumed that the emission distribution can be adequately represented by a Gaussian (puff-type) distribution. User-specified initial size parameters (σ_y, σ_z) and source height are required. The urban emissions may be partitioned according to effective source height and modeled as a number of area sources. Section 3.3 contains more information on the data requirements of area sources.

SECTION 3

USER'S INSTRUCTIONS

3.1 READ56 User's Instructions

READ56 is a preprocessor program designed to read and process a standard NCC TDF5600 rawinsonde data file into a form for input to MESOPAC II. The program extracts sounding levels from the surface to a pressure level specified by the user, flags missing or multiple soundings, and eliminates or flags entries containing missing data. A formatted file of pressure, height, temperature, wind speed, and wind direction is created for possible editing by the user and subsequent input into MESOPAC II. A separate run of READ56 must be made for each rawinsonde station's data to be input to MESOPAC II.

Four system channels are required by READ56. Card-image inputs are read from Logical Unit 5, line printer output is written to Logical Unit 6, the input TDF5600 data is read from Logical Unit 8, and the formatted processed data file is written to Logical Unit 9.

The card-image inputs required by READ56 consists of two records. The first record contains variables used to define the time period of the run, and the top pressure level to be extracted. The second record contains control variables determining how missing data are treated. Figure 7 is a partial listing of the line printer output of a sample READ56 run. Figure 8 contains a portion of the formatted data file created by this run. Each sounding consists of an identification record followed by several data records. The identification record contains: (1) a label identifying the data as series '5600', (2) a station identification number (e.g., 13897), (3) the year, month, day, and hour (GMT) of the sounding (e.g., 78080100),

```
                                                 READ56   VERSION  1.0   LEVEL 821215
***************************************************************************************************************************************

STARTING DATE:                 ENDING DATE:

                YEAR =  78                    YEAR =  78
         JULIAN DAY = 213              JULIAN DAY = 243
                HOUR =   0                    HOUR =   0

PRESSURE LEVELS EXTRACTED:

                     SURFACE TO   500. MB

DATA LEVEL ELIMINATED IF HEIGHT MISSING ?           T

DATA LEVEL ELIMINATED IF TEMPERATURE MISSING ?      T

DATA LEVEL ELIMINATED IF WIND DIRECTION MISSING ? T

DATA LEVEL ELIMINATED IF WIND SPEED MISSING ?       T

THE FOLLOWING SOUNDINGS HAVE BEEN PROCESSED:

      YEAR   MONTH   DAY   JULIAN DAY   HOUR (GMT)   NO. LEVELS EXTRACTED

       78       8      1     213             0                18
       78       8      1     213            12                24
       78       8      2     214             0                20
       78       8      2     214            12                19
       78       8      3     215             0                16
       78       8      3     215            12                24
       78       8      4     216             0                20
       78       8      4     216            12                22
       78       8      5     217             0                22
       78       8      5     217            12                15
       78       8      6     218             0                19
       78       8      6     218            12                19
       78       8      7     219             0                21
       78       8      7     219            12                25
       78       8      8     220             0                17
       78       8      8     220            12                28
       78       8      9     221             0                33
       78       8      9     221            12                19
       78       8     10     222             0                20
       78       8     10     222            12                24
       78       8     11     223             0                22
       78       8     11     223            12                13
->->->MISSING OR ELIMINATED MANDATORY ( 850.0 MB) PRESSURE LEVEL
       78       8     12     224             0                17
       78       8     12     224            12                21
       78       8     13     225             0                21
       78       8     13     225            12                21
       78       8     14     226             0                25
       78       8     14     226            12                14
       78       8     15     227             0                24
       78       8     15     227            12                23
       78       8     16     228             0                19
       78       8     16     228            12                20
       78       8     17     229             0                22
```

Figure 7   Sample READ56 Line Printer Output

```
5600     13897     78 8 1 0     86                                18
 993.5/ 180./301.1/350/  5    979.0/ 310./298.3/347/  6    950.0/ 574./295.9/339/  6    900.0/1045./291.6/316/  6
 875.0/1283./289.3/310/  6    850.0/1530./287.9/304/  7    833.0/1701./286.3/300/  7    819.0/1844./286.1/298/  8
 808.0/1958./288.1/298/  8    800.0/2042./287.6/298/  9    750.0/2583./284.2/295/  9    743.0/2662./283.7/293/  9
 724.0/2878./283.7/286/ 10    700.0/3158./281.5/285/ 10    650.0/3766./278.1/285/ 10    600.0/4415./274.4/284/  8
 550.0/5110./270.4/290/  6    500.0/5859./266.0/311/  9
5600     13897     78 8 112     58                                24
 996.6/ 180./290.9/  0/  0    983.0/ 298./290.9/ 49/  1    965.0/ 457./293.9/ 40/  2    950.0/ 592./293.3/ 16/  3
 944.0/ 647./293.0/  8/  4    925.0/ 822./293.4/358/  5    900.0/1058./291.8/349/  6    872.0/1328./289.9/335/  5
 850.0/1545./288.9/325/  5    802.0/2036./285.9/314/  7    800.0/2057./285.9/314/  7    779.0/2280./285.2/314/ 10
 750.0/2596./283.6/310/ 11    736.0/2753./282.7/311/ 10    712.0/3028./283.1/316/  8    700.0/3169./282.0/318/  8
 681.0/3396./280.2/317/  7    667.0/3567./280.6/314/  7    650.0/3779./279.6/309/  8    610.0/4297./276.8/293/  9
 600.0/4431./275.8/293/  9    550.0/5128./270.4/282/  7    544.0/5214./269.7/278/  7    500.0/5877./266.3/281/  7
5600     13897     78 8 2 0     50                                20
 996.8/ 180./302.8/ 40/  2    983.0/ 304./300.8/ 49/  2    950.0/ 606./298.3/ 45/  2    900.0/1079./294.3/344/  2
 850.0/1570./290.0/290/  4    838.0/1691./289.0/290/  5    808.0/2000./287.8/297/  4    800.0/2084./287.1/299/  4
 750.0/2624./282.5/308/  5    738.0/2758./281.3/303/  6    728.0/2871./282.4/299/  7    700.0/3195./281.0/292/  7
 689.0/3326./280.1/292/  7    650.0/3803./277.8/303/  6    602.0/4425./274.5/312/  5    600.0/4452./274.4/312/  5
 591.0/4573./273.4/309/  5    550.0/5148./271.7/279/  8    548.0/5177./271.6/279/  8    500.0/5901./267.3/287/  9
5600     13897     78 8 212     50                                19
 997.0/ 180./292.9/ 90/  2    964.0/ 473./297.2/193/  4    950.0/ 601./296.4/206/  4    900.0/1072./293.4/254/  4
 850.0/1562./290.1/287/  5    834.0/1724./289.1/292/  4    800.0/2077./286.6/300/  3    797.0/2108./286.3/301/  4
 770.0/2397./284.6/306/  5    750.0/2617./283.4/307/  5    749.0/2628./283.3/305/  5    700.0/3188./279.8/275/  5
 679.0/3438./278.4/274/  5    669.0/3559./277.4/271/  5    650.0/3793./276.2/259/  5    627.0/4085./276.5/250/  5
 600.0/4441./274.4/258/  6    550.0/5135./270.3/262/ 10    500.0/5884./265.7/256/  9
5600     13897     78 8 3 0     82                                16
 994.3/ 180./303.1/220/  3    964.0/ 457./302.8/202/  6    950.0/ 588./301.8/207/  5    900.0/1068./297.7/245/  4
 850.0/1564./293.4/263/  6    800.0/2085./289.3/256/  6    755.0/2575./285.0/252/  7    750.0/2631./284.7/253/  7
 700.0/3206./281.5/261/  7    650.0/3815./277.8/286/  8    600.0/4464./273.8/285/  8    579.0/4750./271.9/285/  7
 554.0/5102./271.2/281/  8    550.0/5160./271.1/281/  8    515.0/5681./269.6/275/  7    500.0/5914./267.3/263/  6
5600     13897     78 8 312     54                                28
 995.5/ 180./294.5/  0/  0    985.0/ 273./296.2/301/  1    951.0/ 581./297.2/295/  4    950.0/ 590./297.2/295/  4
 929.0/ 786./295.8/287/  6    900.0/1062./294.0/274/  6    886.0/1198./293.1/265/  5    850.0/1555./291.8/249/  6
 800.0/2072./288.1/253/  5    759.0/2515./284.8/247/  6    750.0/2615./284.5/245/  7    700.0/3188./282.1/238/  7
 683.0/3591./280.9/246/  8    650.0/3797./277.3/255/  7    645.0/3859./276.8/253/  7    621.0/4167./276.0/250/  6
 600.0/4445./273.8/256/  8    591.0/4566./272.7/260/  8    574.0/4799./271.0/267/  9    552.0/5109./268.8/280/ 10
 550.0/5138./268.7/280/ 10    519.0/5593./265.7/286/ 10    511.0/5714./264.9/283/ 10    500.0/5883./265.1/278/ 10
5600     13897     78 8 4 0     54                                20
 996.4/ 180./295.1/350/  2    980.0/ 325./294.0/350/  3    953.0/ 569./296.0/353/  4    950.0/ 597./295.9/353/  4
 900.0/1067./292.5/359/  6    850.0/1557./288.9/343/  5    816.0/1904./287.3/331/  4    800.0/2071./285.8/324/  4
 786.0/2219./284.3/316/  3    750.0/2611./283.5/317/  3    746.0/2656./283.3/319/  3    731.0/2825./281.0/326/  3
 700.0/3182./279.8/350/  3    650.0/3788./275.8/339/  4    632.0/4015./274.3/331/  3    617.0/4209./274.1/322/  4
 600.0/4434./273.1/316/  5    550.0/5128./269.9/310/  5    526.0/5480./268.3/298/  2    500.0/5877./264.9/245/  3
5600     13897     78 8 412     65                                22
 997.5/ 180./294.4/360/  2    950.0/ 605./295.0/ 64/  8    948.0/ 623./295.1/ 64/  8    900.0/1074./292.1/ 46/  6
 850.0/1563./288.6/ 23/  5    800.0/2076./285.8/  6/  4    783.0/2257./284.7/357/  4    750.0/2617./282.9/355/  2
 742.0/2706./282.4/  3/  2    700.0/3187./279.1/ 67/  1    654.0/3741./275.8/177/  2    650.0/3791./275.6/178/  2
 635.0/3980./274.8/130/  2    623.0/4133./272.7/218/  3    610.0/4302./273.0/229/  3    600.0/4434./272.0/231/  3
 586.0/4622./270.5/223/  3    569.0/4855./269.3/216/  3    553.0/5080./268.5/242/  3    550.0/5123./268.5/244/  3
 536.0/5326./268.3/257/  4    500.0/5869./264.9/227/  6
5600     13897     78 8 5 0     65                                22
 997.5/ 180./296.1/  5/  4    983.0/ 309./297.3/ 12/  6    950.0/ 608./294.8/ 20/  9    905.0/1027./291.1/ 41/  9
 900.0/1075./290.9/ 42/  9    850.0/1563./288.3/ 65/  9    800.0/2076./285.8/ 62/  7    794.0/2140./285.4/ 64/  7
 755.0/2561./282.0/ 77/  5    750.0/2616./281.8/ 78/  5    735.0/2763./281.1/ 76/  5    700.0/3186./280.4/ 70/  6
 669.0/3558./277.3/ 66/  4    659.0/3681./277.3/ 70/  3    650.0/3793./276.8/ 82/  2    608.0/4333./274.0/158/  2
 600.0/4439./273.3/156/  2    563.0/4947./269.7/212/  2    550.0/5132./269.3/226/  3    546.0/5189./269.1/230/  4
 537.0/5320./269.3/235/  4    500.0/5880./265.4/237/  5
5600     13897     78 8 512     62                                15
 998.1/ 180./293.5/360/  1    950.0/ 607./292.4/118/  4    949.0/ 616./292.3/120/  4    900.0/1072./290.1/151/  2
 850.0/1559./287.6/175/  3    800.0/2071./285.4/167/  3    783.0/2252./284.5/163/  2    750.0/2612./282.4/181/  2
 700.0/3182./278.8/146/  5    600.0/3420./278.1/204/  5    650.0/3788./276.1/203/  5    600.0/4434./272.5/193/  6
 550.0/5125./268.5/193/  5    530.0/5416./266.8/177/  7    500.0/5872./265.7/169/ 11
5600     13897     78 8 6 0     56                                19
```

Figure 8 Formatted READ56 Upper Air Data File (Partial Listing)

(4) the total number of sounding levels in the TDF5600 profile (e.g., 46), and (5) the number of sounding levels extracted (e.g., 18).

Mandatory pressure levels (850 mb, 700 mb, 500 mb) missing or eliminated due to missing data are flagged with a warning message in both the line printer output and the formatted data file. The user must edit the formatted data file to delete the warning message and to substitute appropriate values for the missing level. If the control variables were set to flag (rather than eliminate) levels with missing data, the data field of the missing variables are flagged with a series of nines. The run must edit the formatted file to either eliminate the pressure level or replace the missing variables with appropriate values (e.g., interpolated or persisted values).

A complete description of the run control variables used in READ56 follows. Appendix B contains sample test case input and output files for READ56.

READ56 INPUTS

CARD 1 - STARTING AND ENDING HOURS, UPPER PRESSURE LEVEL.

Columns	Type	Variable	Description
*	INTEGER	IBYR	Two-digit starting year of run
*	INTEGER	IBDAY	Starting Julian day
*	INTEGER	IBHR	Starting hour (00 or 12 GMT)
*	INTEGER	IEYR	Two-digit ending year or run
*	INTEGER	IEDAY	Ending Julian day
*	INTEGER	IEHR	Ending hour (00 or 12 GMT)
*	REAL	PSTOP	Top pressure level (mb) for which data is extracted. The formatted READ56 output file will consist of pressure levels from the surface to 'PSTOP'-mb. Possible values of PSTOP are 850 mb, 700 mb, or 500 mb.

---

*Entered in free format.

CARD 2 - MISSING DATA CONTROL VARIABLES.

Columns	Type	Variable	Description
*	LOGICAL	LHT	Height field control variable. If LHT = T, a pressure level is eliminated if the height field is missing. If LHT = F, the pressure level is not eliminated due to the missing height, but will be flagged with a '9999'.
*	LOGICAL	LTEMP	Temperature field control variable. If LTEMP = T, a pressure level is eliminated if the temperature field is missing. If LTEMP = F, the pressure level is not eliminated due to the missing temperature, but will be flagged with a '999.9'.
*	LOGICAL	LWD	Wind direction field control variable. If LWD = T, a pressure level is eliminated if the wind direction field is missing. If LWD = F, the pressure level is not eliminated due to the missing wind direction, but will be flagged with a '999'.
*	LOGICAL	LWS	Wind speed field control variable. If LWS = T, a pressure level is eliminated if the wind speed field is missing. If LWD = F, the pressure level is not eliminated due to the missing wind speed, but will be flagged with a '999'.

---

*Entered in free format.

3.2 MESOPAC II User's Instructions

MESOPAC II is the meteorological preprocessor program that computes time and space interpolated fields of meteorological variables required by MESOPUFF II. The meteorological data inputs required by MESOPAC II are the upper air data files created by READ56 (see Section 3.1), hourly surface meteorological observations, and hourly precipitation data. MESOPAC II and READ56 are designed to use standard-formatted meteorological files available from NCC. The required format for the surface observations is Card Deck 144 (CD144). The surface observations must be at hourly intervals. Because CD144 surface data do not contain hourly precipitation amounts, provisions are made in MESOPAC II to read separate precipitation data files. The format for the precipitation data is Tape Deck 9657 (TD9657), formally called Card Deck 488. MESOPAC II, therefore, will read up to two files for each surface meteorological station - one file containing CD144 data and a second file containing TD9657 data. However, if hourly precipitation (TD9657) data are not available for a particular station, the program allows the CD144 surface observations to be entered alone. MESOPAC II will process the meteorological data for up to 25 surface stations and for up to 10 upper air stations.

The following system input channels are required by MESOPAC II: Logical Unit 5 for card-image inputs, Logical Unit 6 for line printer output, and Logical Unit 8 for binary processed meteorological data output. Additional input channels are required for the upper air, surface and precipitation data files. The user defines the logical unit for each meteorological data file in the run control inputs (see Card Groups 15, 16).

The MESOPAC II output file consists of three header records followed by a set of seven records for each hour. Table 11 contains a complete listing of the variables in each record. The header records contain the date and length of the run, grid size and spacing, land use categories and surface roughness lengths at each grid point, as well as other information required by MESOPUFF II. Each set of seven hourly records contains all the gridded and non-gridded meteorological data needed by MESOPUFF II.

TABLE 11. VARIABLES IN THE BINARY MESOPAC II OUTPUT FILE

HEADER RECORDS - Three records at beginning of output file.

RECORD	VARIABLE	TYPE	DESCRIPTION*
1	NYR	INTEGER	Starting year
1	IDYSTR	INTEGER	Starting Julian day
1	IHRMAX	INTEGER	Number of hours
1	NSSTA	INTEGER	Number of surface stations
1	NUSTA	INTEGER	Number of rawinsonde stations
1	IMAX	INTEGER	Number of grid points in X direction
1	JMAX	INTEGER	Number of grid points in Y direction
1	IBTZ	INTEGER	Reference time zone
1	ILWF	INTEGER	Lower-level wind field code
1	IUWF	INTEGER	Upper-level wind field code
1	DGRID	REAL	Grid spacing (m)
1	VK	REAL	von Karman constant
1	XSCOOR(25)	REAL ARRAY	Surface station X coordinates
1	YSCOOR(25)	REAL ARRAY	Surface station Y coordinates
1	XUCOOR(10)	REAL ARRAY	Upper air station X coordinates
1	YUCOOR(10)	REAL ARRAY	Upper air station Y coordinates
2	Z0(40,40)	REAL ARRAY	Surface roughness lengths (m)
3	NEARS(40,40)	INTEGER*2 ARRAY	Station number of closest surface station to each grid point
3	ILANDU(40,40)	INTEGER*2 ARRAY	Land use categories (see Table 8)

---

[*] See run control input section for complete description of variables.

TABLE 11. (Continued)

HOURLY RECORDS - Repeated for each hour (i) of run.

RECORD	VARIABLE	TYPE	DESCRIPTION
3+i	NYR	INTEGER	Year
3+i	NJULDY	INTEGER	Julian day
3+i	NHR	INTEGER	Hour (00-23)
4+i	UL(IMAX,JMAX)	REAL ARRAY	Lower-level u wind component (m/s)
4+i	VL(IMAX,JMAX)	REAL ARRAY	Lower-level v wind component (m/s)
5+i	UUP(IMAX,JMAX)	REAL ARRAY	Upper-level u wind component (m/s)
5+i	VUP(IMAX,JMAX)	REAL ARRAY	Upper-level v wind component (m/s)
6+i	ZI(IMAX,JMAX)	REAL ARRAY	Boundary layer height (m)
6+i	USTAR(IMAX,JMAX)	REAL ARRAY	Friction velocity (m/s)
7+i	WSTAR(IMAX,JMAX)	REAL ARRAY	Convective velocity scale (m/s)
7+i	CAPL(IMAX,JMAX)	REAL ARRAY	Monin-Obukhov length (m)
8+i	IPGT(IMAX,JMAX)	INTEGER*2 ARRAY	PGT stability class
9+i	AVRHO	REAL	Average surface air density (kg/m^3)
9+i	PAMT(25)	REAL ARRAY	Hourly precipitation rate*(mm/hr)
9+i	TEMPK(25)	REAL ARRAY	Air temperature*(K)
9+i	SRAD(25)	REAL ARRAY	Total solar radiation*(W/m^2)
9+i	IRH(25)	INTEGER*2 ARRAY	Relative humidity*(%)
9+i	ICC(25)	INTEGER*2 ARRAY	Opaque cloud cover*(tenths)
9+i	IPCODE(25)	INTEGER*2 ARRAY	Precipitation code*(see Table 10)

---

*At surface meteorological stations.

Following this section is a complete description of all the run control variables used in MESOPAC II. Figure 9 shows the required setup of the card image inputs. Appendix C contains a set of sample test case inputs and output.

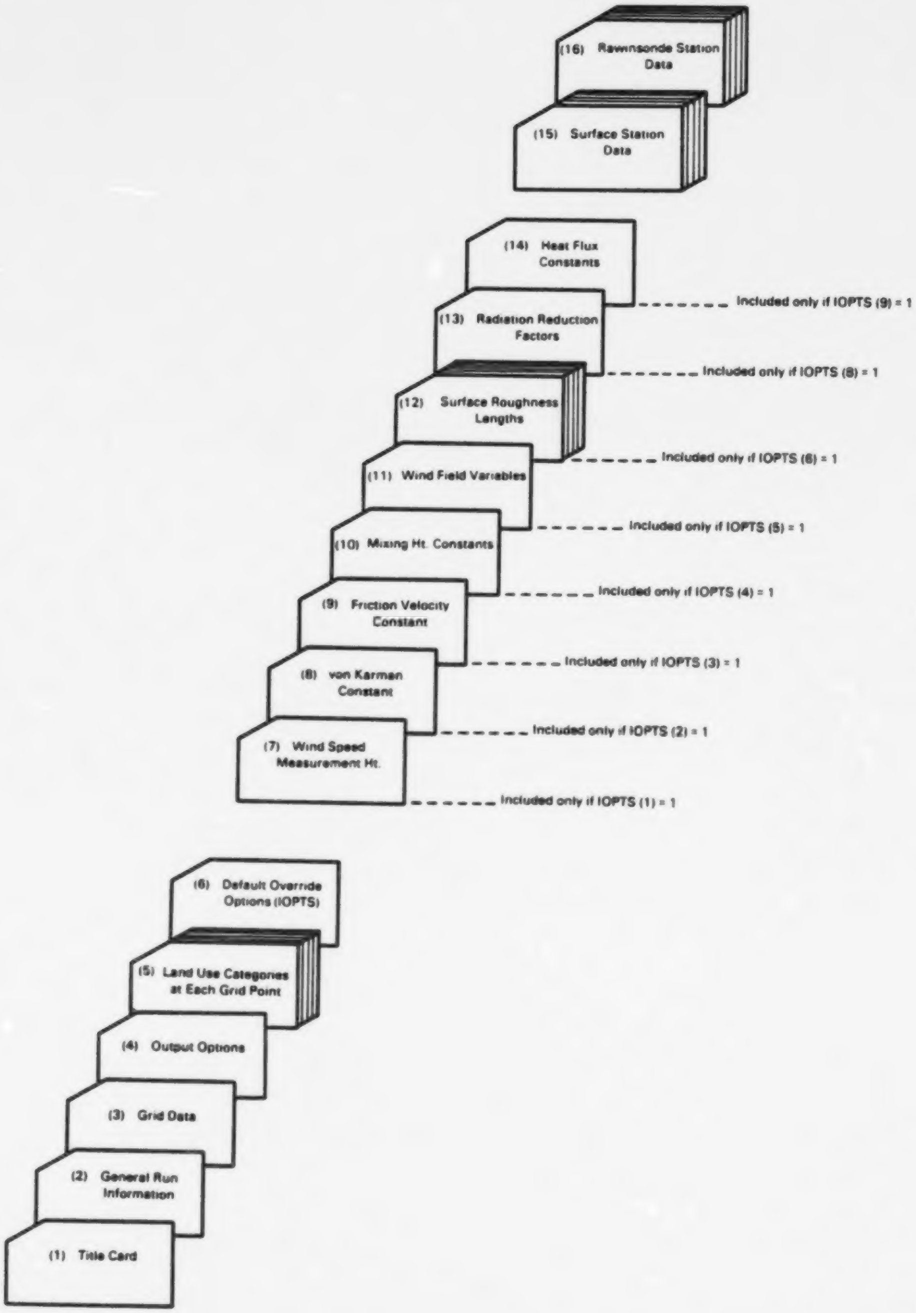
(16) Rawinsonde Station Data
(15) Surface Station Data
(14) Heat Flux Constants
Included only if IOPTS (9) = 1
(13) Radiation Reduction Factors
Included only if IOPTS (8) = 1
(12) Surface Roughness Lengths
Included only if IOPTS (6) = 1
(11) Wind Field Variables
Included only if IOPTS (5) = 1
(10) Mixing Ht. Constants
Included only if IOPTS (4) = 1
(9) Friction Velocity Constant
Included only if IOPTS (3) = 1
(8) von Karman Constant
Included only if IOPTS (2) = 1
(7) Wind Speed Measurement Ht.
Included only if IOPTS (1) = 1
(6) Default Override Options (IOPTS)
(5) Land Use Categories at Each Grid Point
(4) Output Options
(3) Grid Data
(2) General Run Information
(1) Title Card

Figure 9 Input Deck Setup for MESOPAC II

MESOPAC II INPUTS

CARD GROUP 1 - TITLE

Columns	Type	Variable	Description
1-80	CHARACTER ARRAY	TITLE (20)	80-character title.

CARD GROUP 2 - GENERAL RUN INFORMATION

Columns	Type	Variable	Description
1-5	INTEGER	NYR	Two digit year of run.
6-10	INTEGER	IDYSTR	Starting Julian day (also see Card Group 6, IOPTS (10)).
11-15	INTEGER	IHRMAX	Number of hours in run.
16-20	INTEGER	NSSTA	Number of surface meteorological stations (must be $\leq$ 25).
21-25	INTEGER	NUSTA	Number of rawinsonde stations (must be $\leq$10).
26-30	INTEGER	IBTZ	Reference time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).

CARD GROUP 3 - GRID DATA

Columns	Type	Variable	Description
1-5	INTEGER	IMAX	Number of grid points in X (west-east) direction (must be $\leq$ 40).
6-10	INTEGER	JMAX	Number of grid points in Y (south-north) direction (must be $\leq$ 40)
11-20	REAL	DGRID	Grid spacing (m).

MESOPAC II INPUTS

CARD GROUP 4 - OUTPUT OPTIONS

Columns	Type	Variable	Description
1-5	LOGICAL	LSAVE	Disk/tape output control variable. If LSAVE =T, meterological fields are written to a disk/tape file. If LSAVE = F, output is not stored on disk/tape. (LSAVE should be T if meteorological data is to be used to run MESOPUFF II).
6-10	LOGICAL	LPRINT	Printer output control variable. If LPRINT = T, meteorological fields are printed every 'IPRINF' hours. If LPRINT = F, meteorological fields are not printed.
11-15	INTEGER	IPRINF	Printing interval (in hours) of meterological fields. Used only if LPRINT = T. (IPRINF ≥ 1).
16-20	LOGICAL	LBD	Control variable for printing of input meteorological data and intermediate computed parameters. If LBD = T, these data will be printed for time periods specified by NDY1, NHR1, NDY2, and NHR2. If LBD = F, these data will not be printed. (Because this information is not of general interest, LBD should be F for most applications).
21-25	INTEGER	NDY1	Julian day for which printing or input meteorological data and intermediate computed parameters begins. Used only if LBD = T.
26-30	INTEGER	NHR1	Hour (00-23) for which printing of input meteorological data and intermediate computed parameters ends. Used only if LBD = T.
31-35	INTEGER	NDY2	Julian day for which printing of input meteorological data and intermediate computed parameters ends. Used only if LBD = T.
36-40	INTEGER	NHR2	Hour (00-23) for which printing of input meteorological data and intermediate computed parameters ends. Used only if LBD = T.

CARD GROUP 5 - LAND USE CATEGORIES AT EACH GRID POINT (see Table 8). 'JMAX' cards are required, each card with 'IMAX' land use categories (corresponding to X-coordinates 1 to IMAX). The first card contains values for Y = JMAX, the second card for Y = JMAX-1, etc.

Columns	Type	Variable	Description
1-80	INTEGER ARRAY	ILANDU(40,40)	Land use categories for each grid point.

Example:

```
3 4
1 2
```

Results in ILANDU (1,1) = 1, ILANDU (2,1) = 2
ILANDU (1,2) = 3, ILANDU (2,2) = 4.

MESOPAC II INPUTS

CARD GROUP 6 - DEFAULT OVERRIDE OPTIONS.

Columns	Type	Variable	Description
1	INTEGER ARRAY ELEMENT	IOPTS(1)	Surface wind speed measurement height control variable. If IOPTS (1) = 1, the user must input the height at which the surface wind speed was measured (see Card Group 7). If IOPTS(1) = 0, a default value of 10.0 m is used.
2	INTEGER ARRAY ELEMENT	IOPTS(2)	von Karman constant control variable. If IOPTS(2) = 1, the user must input a value of the von Karman constant (see Card Group 8). If IOPTS(2) = 0, a default value of 0.4 is used.
3	INTEGER ARRAY ELEMENT	IOPTS(3)	Control variable for input of friction velocity constants (γ, A) in Equation 2-21. If IOPTS(3) = 1, the user must input values for γ and A (see Card Group 9). If IOPTS(3) = 0, the default variables $\gamma = 4.7$, A = 1100 are used.
4	INTEGER ARRAY ELEMENT	IOPTS(4)	Control variable for input of mixing height constants (B, E, $\Delta z, \partial\theta/\partial z_{min}$, N) in Equations (2-24)-(2-27). If IOPTS(4) = 1, the user must input values for these constants (see Card Group 10). If IOPTS (4)=0, the following default values are used; B = 1.41, E = 0.15, $\Delta z = 200$ m, $\partial\theta/\partial z_{min} = 0.0010$°K/m, N = 2400.
5	INTEGER ARRAY ELEMENT	IOPTS(5)	Control variable for input of wind field variables RADIUS, ILWF, IUWF. See Card Group 11 for a description of these variables. If IOPTS (5)=1 , the user must input values for these variables. If IOPTS(5) = 0, the following defaults are used: RADIUS = 99 grid units, ILWF = 2, IUWF = 4.
6	INTEGER ARRAY ELEMENT	IOPTS(6)	Control variable for surface roughness lengths. If IOPTS(6) = 1, the user must input the roughness length at each grid point (see Card Group 12). If IOPTS(6) = 0, the roughness length is determined by the land use category for each grid point according to Table 8.

CARD GROUP 6 - DEFAULT OVERRIDE OPTIONS.

Columns	Type	Variable	Description
7	INTEGER ARRAY ELEMENT	IOPTS(7)	Option to adjust heat flux estimates using 00Z sounding data and Equation 2-24. This option is not currently active. IOPTS(7) must be 0.
8	INTEGER ARRAY ELEMENT	IOPTS(8)	Control variable for input of radiation reduction factors due to cloud cover. If IOPTS(8)=1, the user must input eleven radiation reduction factors corresponding to possible opaque sky cover of 0-10 tenths. (see Card Group 14). If IOPTS(8) = 0, the following default reduction factors are used; 1.00, 0.91, 0.84, 0.79, 0.75, 0.72, 0.68, 0.62, 0.53, 0.41, 0.23.
9	INTEGER ARRAY ELEMENT	IOPTS(9)	Control variable for inputs of heat flux constants of Equation 2-2 at each grid point. If IOPTS(9) = 1, the user must input a value of RADC for each grid point (see Card Group 15). If IOPTS(9) = 0, a default value of RADC = 0.3 is assigned to each grid point.
10	INTEGER ARRAY ELEMENT	IOPTS(10)	Option to begin run at point other than at beginning of surface and upper air data files. IOPTS(10) must be 1 if the starting date of the model run does not correspond to the beginning of the meteorological files; otherwise, IOPTS(10) must be 0.

MESOPAC II INPUTS

CARD GROUP 7 - WIND SPEED MEASUREMENT HEIGHT (Optional - included only if IOPTS(1) = 1).

Columns	Type	Variable	Default	Description
1-10	REAL	ZM	10.0	Surface height above ground (in meters) at which wind speed measurements were made.

CARD GROUP 8 - VON KARMAN CONSTANT (Optional - included only if IOPTS(2) = 1).

Columns	Type	Variable	Default	Description
1-10	REAL	VK	0.4	von Karman constant.

CARD GROUP 9 - FRICTION VELOCITY CONSTANTS (Optional - included only if IOPTS(3) = 1).

Columns	Type	Variable	Default	Description
1-10	REAL	GAMMA	4.7	Constant γ in friction velocity Equation 2-21.
11-20	REAL	CONSTA	1100.	Constant A in friction velocity Equation 2-21.

CARD GROUP 10 - MIXING HEIGHT CONSTANTS (Optional - included only if IOPTS(4) = 1).

Columns	Type	Variable	Default	Description
1-10	REAL	CONSTB	1.41	Constant B in neutral stability mixing height Equation 2-26.
11-20	REAL	CONSTE	0.15	Constant E in convective mixing height Equations (2-25)-(2-26).
21-30	REAL	DELTZ	200.	Depth of layer above current convective height through which potential temperature gradient $\partial\theta/\partial z$ is calculated.
31-40	REAL	DPTMIN	0.001	Minimum $\partial\theta/\partial z$ (°K/m) used in Equations (2-25)-(2-26).
41-50	REAL	CONSTN	2400.	Constant N in stable (mechanical) mixing height Equation 2-27.

MESOPAC II INPUTS

CARD GROUP 11 - WIND FIELD VARIABLES (Optional - included only if IOPTS(5) = 1).

Columns	Type	Variable	Default	Description
1-5	INTEGER	ILWF	2	Code for lower-level wind field (see below).
6-10	INTEGER	IUWF	4	Code for upper-level wind field (see below).
11-20	REAL	RADIUS	99.	Scan radius for wind field interpolation (in grid units).

Wind Field Code (ILWF, IUWF)

1 - Surface winds (uses CD144 surface data only)

2 - Vertically-averaged winds through layer from ground to mixing height (uses CD144 surface data and TDF5600 rawinsonde data).

3 - Vertically-averaged winds through layer from mixing height to 850 mb (uses TDF5600 rawinsonde data only).

4 - Vertically-averaged winds through layer from mixing height to 700 mb (uses TDF5600 rawinsonde data only).

5 - Vertically-averaged winds through layer from mixing height to 500 mb (uses TDF5600 rawinsonde data only).

6 - 850 mb winds (uses TDF5600 rawinsonde data only).

7 - 700 mb winds (uses TDF5600 rawinsonde data only).

8 - 500 mb winds (uses TDF5600 rawinsonde data only).

CARD GROUP 12 - SURFACE ROUGHNESS LENGTHS (Optional - included only if IOPTS(6) = 1)

Columns	Type	Variable	Default	Description
1-80 (16F5.0)	Real Array	Z0	*	Surface roughness lengths (m). If IMAX <16, JMAX cards are required, each card with IMAX Z0 values (corresponding to X grid points 1 to IMAX). Cards are in order of decreasing Y. See example in description of Card Group 5. If 16 < IMAX < 32, 2 x JMAX cards are required. (Each Z0 (1,J) starts on a new card). If IMAX > 32, 3 x JMAX cards are required.

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*Default roughness lengths are determined by the land use category assigned to each grid point (in Card Group 5) according to Table 8.

CARD GROUP 13 - RADIATION REDUCTION FACTORS (Optional - included only if IOPTS(8) = 1)

Columns	Type	Variable	Default	Description
1-55 (11F5.0)	REAL ARRAY	BETA(11)	1.00, 0.91, 0.84 0.79, 0.75, 0.72, 0.68, 0.62, 0.53, 0.41, 0.23	Radiation reduction factors due to presence of clouds (see Equation (2-3)). Eleven values corresponding to opaque sky cover of 0-10 tenths.

CARD GROUP 14 - HEAT FLUX CONSTANT (Optional - included only if IOPTS(9) = 1)

Columns	Type	Variable	Default	Description
1-80 (16F5.0)	REAL ARRAY	RADC	1600*0.3	Heat flux constant, α, of Equation 2-2, for each grid point. If IMAX < 16, JMAX cards are required, each card with IMAX values (corresponding to X grid points 1 to IMAX). Cards are in order of decreasing Y. See example in description of Card Group 5. If 16 < IMAX ≤32, 2 x JMAX cards are required. Each RADC (1,J) starts on a new card. If IMAX >32, 3 x JMAX cards are required.

CARD GROUP 15 - SURFACE STATION DATA. 'NSSTA' cards - one for each CD144/TD9657 surface station

Columns	Type	Variable	Description
1-5	INTEGER ARRAY ELEMENT	IDCD	Surface station ID for CD144 data (5 digits).
6-15	REAL ARRAY ELEMENT	XSCOOR	X-coordinate of station (in grid units).
16-25	REAL ARRAY ELEMENT	YSCOOR	Y-coordinate of station (in grid units).
26-35	REAL ARRAY ELEMENT	SLAT	Station latitude (decimal degrees).
36-45	REAL ARRAY ELEMENT	SLONG	Station longitude (decimal degrees).
46-50	REAL ARRAY ELEMENT	SZONE	Station time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).
51-55	INTEGER ARRAY ELEMENT	ISUNIT	Logical unit number of CD144 surface data.
56-65	INTEGER ARRAY ELEMENT	IDPRCP	Surface station ID for TD9657 data (6 digits).
66-70	INTEGER ARRAY ELEMENT	IPUNIT	Logical unit number of TD9657 data (IPUNIT = 999 if TD9657 data is not available for this station).

CARD GROUP 16 - RAWINSONDE STATION DATA. 'NUSTA' cards - one for each TDF5600 Rawinsonde Station

Columns	Type	Variable	Description
1-5	INTEGER ARRAY ELEMENT	IDTD	Rawinsonde station identification number (5 digits).
6-15	REAL ARRAY ELEMENT	XUCOOR	X-coordinate of station (in grid units).
16-25	REAL ARRAY ELEMENT	YUCOOR	Y-coordinate of station (in grid units).
26-35	REAL ARRAY ELEMENT	ULAT	Station latitude (decimal degrees).
36-45	REAL ARRAY ELEMENT	ULONG	Station longitude (decimal degrees).
46-50	REAL ARRAY ELEMENT	UZONE	Station time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).
51-55	INTEGER ARRAY ELEMENT	IUUNIT	Logical unit of processed TDF5600 data. (READ56 output)

3.3 MESOPUFF II User's Instructions

MESOPUFF II is a variable-trajectory, puff superposition model designed to account for the spatial ad temporal variations in transport, diffusion, chemical transformations, and removal mechanisms encountered on regional scales. Continuous plumes are modeled as a series of discrete puffs. Each puff is transported independently of other puffs, and is subject to growth by diffusion, chemical transformation, wet removal by precipitation, and dry deposition at the surface. MESOPUFF II will model up to five pollutants (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-) simultaneously. Up to twenty point sources and five area sources are allowed. A maximum of 180 non-gridded (discrete) receptors and 1600 (40 x 40) gridded receptors is allowed.

The following system input channels are required by MESOPUFF II: Logical Unit 5 for card-image inputs, Logical Unit 6 for line printer output, Logical Unit 8 for input of processed (MESOPAC II) meteorological data, and, if disk concentration output is requested, Logical Unit 20 for these data. In addition, the chemical transformation submodule (see Section 2.3.6) allows for the input of hourly ozone measurements at up to 15 stations on Logical Unit 10. Table 12 contains the ozone data input format.

The MESOPUFF II concentration output file consists of a single header record followed by up to two records per hour containing concentration data. Table 13 contains a complete listing of the variables in each record. The header record contains a number of technical option control parameters and other run control inputs. One or two records per hour follow the header record. Two records are written each hour if concentrations are predicted at both gridded and non-gridded receptors. If only one type of receptor is used, only one record per hour is written.

Following this section is a complete description of all the run control variables used in MESOPUFF II. Figure 10 shows the required setup of the card-image inputs. Appendix D contains a set of sample test case input and output.

TABLE 12. FORMAT OF OPTIONAL HOURLY OZONE INPUT DATA

Columns	Type	VARIABLE	DESCRIPTION
1-8 (4I2)	INTEGER	IDATE (4)	Year, Month, Day, Hour
9-68 (15F4.0)	REAL ARRAY	OZPPB (15)	Ozone concentrations (ppb) at up to 15 stations. A '999.' signifies missing data.

TABLE 13. VARIABLES IN THE MESOPUFF II OUTPUT CONCENTRATION FILE

HEADER RECORD - One record at the beginning of the output file

Record	Variable	Type	Description
1	VERSON	REAL	MESOPUFF II version number
1	LEVEL	INTEGER	MESOPUFF II level number
1	NSYR	INTEGER	Starting year
1	NSDAY	INTEGER	Starting Julian day
1	NSHR	INTEGER	Starting hour (00-23)
1	NADVTS	INTEGER	Number of hours
1	IAVG	INTEGER	Averaging time (hours)
1	NPUF	INTEGER	Puff release rate (puffs/hour)
1	NSAMAD	INTEGER	Minimum sampling rate (samples/hour)
1	IELMET	INTEGER	Number of met. grid points (X direction)
1	JELMET	INTEGER	Number of met. grid points (Y direction)
1	DGRID	REAL	Grid spacing (m)
1	IASTAR	INTEGER	Start of computational grid (X direction)
1	IASTOP	INTEGER	End of computational grid (X direction)
1	JASTAR	INTEGER	Start of computational grid (Y direction)
1	JASTOP	INTEGER	End of computational grid (Y direction)
1	ISASTR	INTEGER	Start of sampling grid (X direction)
1	ISASTP	INTEGER	End of sampling grid (X direction)
1	JSASTR	INTEGER	Start of sampling grid (Y direction)
1	JSASTP	INTEGER	End of sampling grid (Y direction)
1	MESHDN	INTEGER	Sampling grid spacing factor
1	NPTS	INTEGER	Number of point sources
1	NAREAS	INTEGER	Number of area sources
1	NREC	INTEGER	Number of non-gridded receptors
1	XREC(180)	REAL ARRAY	X coordinates of non-gridded receptors
1	YREC(180)	REAL ARRAY	Y coordinates of non-gridded receptors
1	IPRINF	INTEGER	Printing interval
1	LGAUSS	LOGICAL	Vertical conc. distribution option
1	LCHEM	LOGICAL	Chemical transformation control variable
1	LDRY	LOGICAL	Dry deposition control variable
1	LWET	LOGICAL	Wet removal control variable
1	LPRINT	LOGICAL	Printer output control variable
1	L3VL	LOGICAL	Three vertical layer control variable
1	LVSAMP	LOGICAL	Variable sampling rate control variable
1	WSAMP	REAL	Reference wind speed for LVSAMP option
1	LSGRID	LOGICAL	Gridded receptor control variable
1	NSPEC	INTEGER	Number of chemical species modeled

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*See run control inputs for a complete description of variables.

TABLE 13. (Continued)

HOURLY RECORDS - Repeated for each hour (i) of run.

Record	Variable	Type	Description
1+i*	IDPOL(4)	INTEGER ARRAY	Year, Julian day, ending hour, and pollutant number
1+i*	ROUT2 (IX,JX)***	REAL ARRAY	Gridded receptor concentrations (g/m^3)
2+i**	IDPOL(4)	INTEGER ARRAY	Year, Julian day, ending hour, and pollutant number
2+i**	RIN1(NREC)	REAL ARRAY	Non-gridded receptor concentrations (g/m^3)

---

*Written only if LVSAMP=.TRUE.

**Written only if NREC > 0

***(IX,JX) is the sampling grid size.

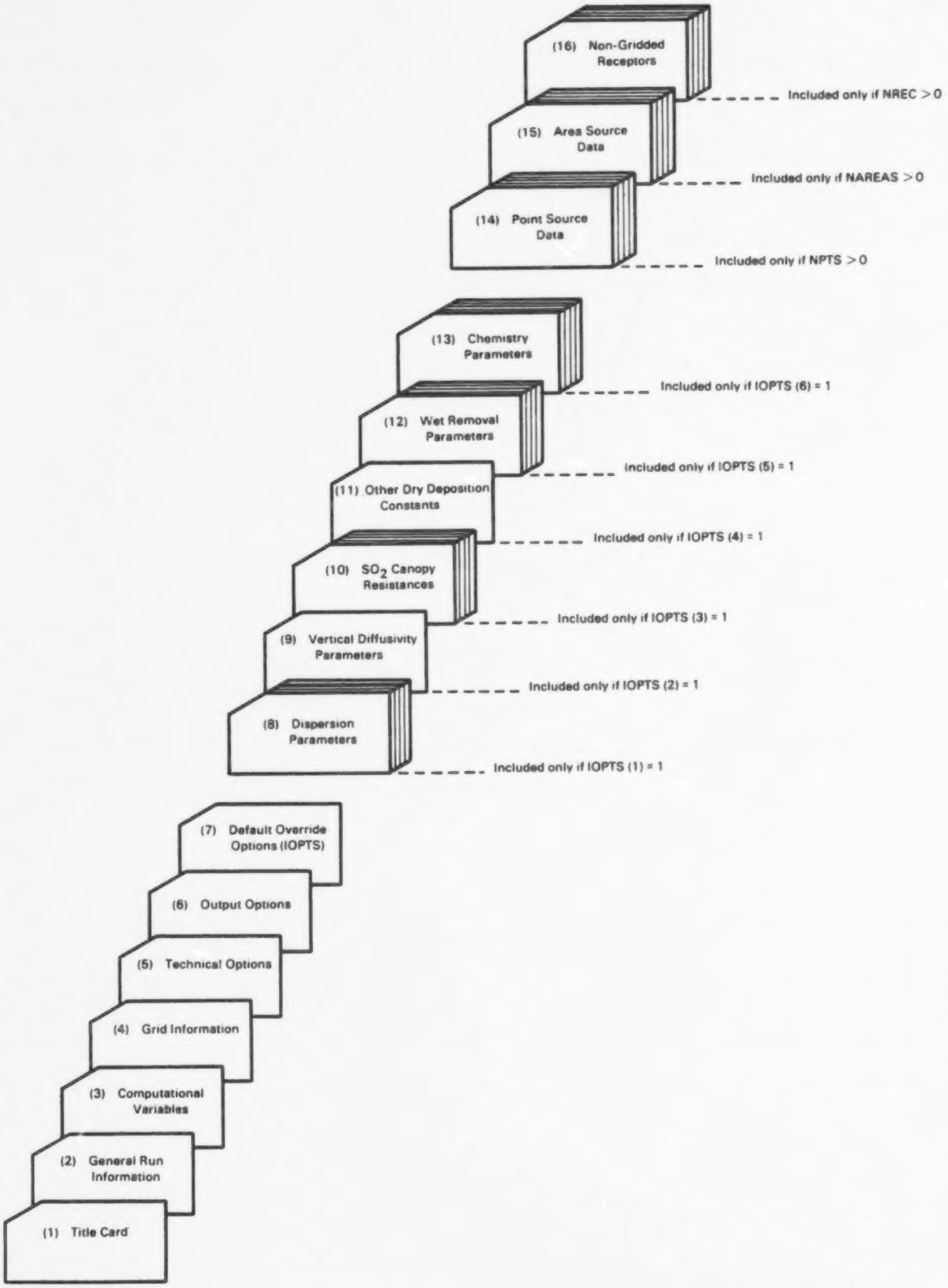
(16) Non-Gridded Receptors
Included only if NREC > 0
(15) Area Source Data
Included only if NAREAS > 0
(14) Point Source Data
Included only if NPTS > 0
(13) Chemistry Parameters
Included only if IOPTS (6) = 1
(12) Wet Removal Parameters
Included only if IOPTS (5) = 1
(11) Other Dry Deposition Constants
Included only if IOPTS (4) = 1
(10) SO2 Canopy Resistances
Included only if IOPTS (3) = 1
(9) Vertical Diffusivity Parameters
Included only if IOPTS (2) = 1
(8) Dispersion Parameters
Included only if IOPTS (1) = 1
(7) Default Override Options (IOPTS)
(6) Output Options
(5) Technical Options
(4) Grid Information
(3) Computational Variables
(2) General Run Information
(1) Title Card
8304010

Figure 10   Input Deck Setup for MESOPUFF II

MESOPUFF II INPUTS

CARD GROUP 1 - TITLE

Columns	Type	Variable	Description
1-80	CHARACTER ARRAY	TITLE (20)	80-character title

CARD GROUP 2 - GENERAL RUN INFORMATION

Columns	Type	Variable	Description
1-5	INTEGER	NSYR	Two-digit year of run.
6-10	INTEGER	NSDAY	Starting Julian day.
11-15	INTEGER	NSHR	Starting hour (00-23).
16-20	INTEGER	NADVTS	Number of hours in run.
21-25	INTEGER	NPTS	Number of point sources (NPTS $\leq$20).
26-30	INTEGER	NAREAS	Number of area sources (NAREAS $\leq$5).
31-35	INTEGER	NREC	Number of non-gridded receptors (NREC $\leq$180).
36-40	INTEGER	NSPEC	Number of chemical species to model (NSPEC = 1,2,3 or 5). NSPEC = 1 for SO_2; NSPEC = 2 for SO_2, $SO_4^=$; NSPEC = 3 for SO_2, $SO_4^=$, NO_x; NSPEC = 5 for SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-.

CARD GROUP 3 - COMPUTATIONAL VARIABLES

Columns	Type	Variable	Description
1-5	INTEGER	IAVG	Concentration averaging time (hours).
6-10	INTEGER	NPUF	Puff release rate (puffs/hour) for each source.
11-15	INTEGER	NSAMAD	Minimum sampling rate (samples/hour).
16-20	LOGICAL	LVSAMP	Control variable for variable sampling rate option. IF LVSAMP = T, the sampling rate, NSAM, will be increased at higher wind speeds according to the following equation: NSAM = maximum (NSAMAD, WS/WSAMP + 1) where WS is the wind speed (m/s), and WSAMP is a user input reference wind speed (see below). If LVSAMP = F, the sampling rate is not varied with wind speed.
21-25	REAL	WSAMP	Reference wind speed used in variable sampling rate option. Used only if LVSAMP = T. See description of LVSAMP.
26-30	LOGICAL	LSGRID	Control variable for concentration computations at sampling grid points. If LSGRID = T, concentrations are calculated at sampling grid points. (Parameters defining sampling grid are contained in Card Group 4). If LSGRID = F, concentrations are not calculated at sampling grid points. This option allows significant savings of computation time if only concentrations at non-gridded receptors are of interest.
31-35	REAL	AGEMIN	Minimum age of puffs to be sampled (in seconds). Puffs released at a time AGEMCN are not sampled. This option is intended to eliminate near-field concentration spikes at receptors located very close to sources. In general, AGEMIN should not be larger than 3600 s.

MESOPUFF II INPUTS

CARD GROUP 4 - GRID INFORMATION (See Section 2.3.2 for description of the meteorological, computational and sampling grids).

Columns	Type	Variable	Description
1-5	INTEGER	IASTAR	Element number of the meteorological grid defining the beginning of the computational grid in the X-direction. (1 $\le$ IASTAR $\le$ IMAX, where IMAX is the meteorological grid size in the X-direction defined in the MESOPAC II run).
6-10	INTEGER	IASTOP	Element number of the meteorological grid defining the end of the computational grid in the X-direction. (IASTAR $\le$ IASTOP $\le$ IMAX).
11-15	INTEGER	JASTAR	Element number of the meteorological grid defining the end of the computational grid in the Y-direction. (1 $\le$ JASTAR $\le$ JMAX, where JMAX is the meteorological grid size in the Y-direction defined in the MESOPAC II run).
16-20	INTEGER	JASTOP	Element number of the meteorological grid defining the end of the computational grid in the Y-direction. (1 $\le$ ISASTR $\le$ IASTAR).
21-25	INTEGER	ISASTR	Element number of the meteorological grid defining the beginning of the sampling grid in the X-direction. (1 $\le$ ISASTR $\le$ IASTAR).
26-30	INTEGER	ISASTP	Element number of the meteorological grid defining the end of the sampling grid in the X-direction. (ISASTR $\le$ ISASTP $\le$ IASTOP).
31-35	INTEGER	JSASTR	Element number of the meteorological grid defining the beginning of the sampling grid in the Y-direction. (1 $\le$ JSASTR $\le$ JASTAR).
36-40	INTEGER	JSASTP	Element number of the meteorological grid defining the end of the sampling grid in the Y-direction. (JSASTR $\le$ JSASTP $\le$ JASTOP).

CARD GROUP 4 - GRID INFORMATION (Continued)

Columns	Type	Variable	Description
41-45	INTEGER	MESHDN	Sampling grid spacing factor. Sampling grid spacing is DGRID/MESHDN, where DGRID is the meteorological grid spacing (m) defined in the MESOPAC II run. NOTE: The sampling grid must be defined as not to exceed a maximum size of 40 x 40.

CARD GROUP 5 - TECHNICAL OPTIONS.

Columns	Type	Variable	Description
1-5	LOGICAL	LGAUSS	Vertical concentration distribution option. If LGAUSS=T, a Gaussian vertical concentration distribution with reflection terms (Equation 2-30) is assumed for each puff. If LGAUSS = F, fumigated puffs immediately assume a uniform vertical concentration distribution.
6-10	LOGICAL	LCHEM	Chemical transformation option. If LCHEM = T, chemical transformation processes are modeled. If LCHEM = F, chemical processes are not modeled.
11-15	LOGICAL	LDRY	Dry deposition option. If LDRY = T, dry deposition is modeled. If LDRY = F, dry deposition is not modeled.
16-20	LOGICAL	LWET	Wet removal option. If LWET = T, wet removal is modeled. If LWET = F, wet removal is not modeled.
21-25	LOGICAL	L3VL	Three vertical layer option. L3VL = T, the 3-vertical layer model described in Section 2.3.4 is used for puffs that have become uniformly mixed in the vertical. If L3VL = F, the single layer model is assumed. NOTE: L3VL may be T with LGAUSS = T or F; however, if LGAUSS = T, the 3-layer treatment does not begin until the puffs have become uniformly mixed through the boundary layer.

MESOPUFF II INPUTS

CARD GROUP 6 - OUTPUT OPTIONS

Columns	Type	Variable	Description
1-5	LOGICAL	LSAVE	Disk/tape output control variable. If LSAVE = T, concentrations are written to a disk/tape file. If LSAVE = F, concentration output is not stored on tape/disk.
6-10	LOGICAL	LPRINT	Printer output control variable. If LPRINT = T, concentrations are printed every 'IPRINT' hours. If LPRINT = F, concentrations are not printed..
11-15	LOGICAL	IPRINT	Printing interval (in hours) of concentrations. Used only if LPRINT = T. IPRINT must be equal to or an even multiple of IAVG.
16-20	LOGICAL	LDB	Control variable for printing of computed puff data (puff height, σ_y, σ_z, location, transformation rate, rate, deposition velocity, wet removal rate, etc.). If LDB = T, these data will be printed for time steps NN1 to NN2. If LDB = F, this information will not be printed. This option will produce a large quantity of printout, and, for most applications should be F.
21-25	INTEGER	NN1	Time step at which printing of intermediate computed puff data begins. Used only if LDB = T. ($1 \leq NN1 \leq NADVTS$).
26-30	INTEGER	NN2	Time step at which printing of intermediate computed puff data ends. Used only if LDB = T. ($NN1 \leq NN2 \leq NADVTS$).

TABLE 14. MESOFILE II CARD-IMAGE INPUTS AND SUBROUTINE IDENTIFIERS

MESOFILE II CARD INPUTS

- TITLE CARD

Up to 64 characters (columns 1-64) (followed by one set of cards as specified below for each subroutine requested by the user)

- SUBROUTINE IDENTIFIER CARD

Contains 4-letter subroutine identifier (in Columns 1-4)

- NAMELIST INPUT CARD #1

Read by the subroutine called

- NAMELIST INPUT CARD #2

Read by the line printer plotting routine (needed only if line printer plots are produced and contour levels other than the default contour levels are used).

SUBROUTINE IDENTIFIER	CALLING ORDER GROUP	SUBROUTINE FUNCTION (see detailed subroutine descriptions - Sections 3.4.1-3.4.7)
• DEFN	A	Defines Pollutant, Grid Size, and Routes Output
• FIND	B	Locates First Order Model Output
• SEEK	B	Locates Higher Order MESOFILE II Output
• AVRG	C	Averages Arrays
• ADD1	C	Sums Arrays within one runstream
• ADD2	C	Sums Arrays from two runstreams
• STAT	C	Calculates Statistics

3.4. MESOFILE II User's Instructions

MESOFILE II is a postprocessing program that operates on the concentration file produced by MESOPUFF II. It consists of a set of modular subroutines that the user explicitly invokes by card (or card-image) inputs to construct the desired sequence of postprocessing operations. The modular nature of MESOFILE II provides powerful flexibility. It is possible to perform a wide variety of postprocessing operations in a sequence specifically designed to meet the user's particular needs. These features of modularity and flexibility, however, require a greater degree of user interface than a simple "black box" postprocessing program. The MESOFILE II card inputs required for the most common applications of the program are presented as examples in Section 3.4.8.

The following system channels are required for MESOFILE II: Logical Unit 5 for card-image inputs, Logical Unit 6 for line printer outputs, and Logical Unit 25 for MESOFILE II disk output. Logical Unit 25 is a direct-access file used to store MESOFILE II results for subsequent analysis and/or plotting. Additional channels, defined by the user, are required for input of MESOPUFF II concentration files (see inputs to subroutine FIND).

The main program of MESOFILE II reads the user's card inputs and calls the appropriate subroutines. There are seven subroutines available to perform a variety of postprocessing functions. Other second-level subroutines, transparent to the user, are invoked as appropriate by the user-called subroutines. Table 14 contains a description of the basic form of the card inputs to MESOFILE II, as well as a list of the subroutines and their functions that are available to the user. Each subroutine requested by the user (with subroutine identifier cards) is called, in order, as it appears in the inputs. There are, however, some restrictions on the order in which subroutines may be called. For example, the pollutant of interest must be specified before the concentration data can be located; therefore, the subroutine identified in Table 14 as belonging to calling order Group A must precede those in Group B. Likewise, because data must be located before they can be processed, the subroutines in Group B must be called

MESOPUFF II INPUTS

CARD GROUP 16 - NON-GRIDDED RECEPTOR COORDINATES. 'NREC' cards required - one card for each non-gridded receptor.

Columns	Type	Variable	Description
1-10	REAL ARRAY ELEMENT	XREC	X-coordinate of non-gridded receptor (in meteorological grid units).
11-20	REAL ARRAY ELEMENT	YREC	Y-coordinate of non-gridded receptor (in meteorological grid units).

MESOPUFF II INPUTS

CARD GROUP 15 - AREA SOURCE DATA. 'NAREAS' cards required - one for each area source.

Columns	Type	Variable	Description
1-5	REAL ARRAY ELEMENT	XAR	X-coordinate of area source center (in meteorological grid units).
6-10	REAL ARRAY ELEMENT	YAR	Y-coordinate of area source center (in meteorological units).
11-15	REAL ARRAY ELEMENT	HTAR	Effective height of area source (m).
16-20	REAL ARRAY ELEMENT	SIGYAR	Initial σ_y(m) of area source emissions.
21-25	REAL ARRAY ELEMENT	SIGZAR	Initial σ_z(m) of area source emissions.
26-75 (5F10.2)	REAL ARRAY ELEMENTS	EMISAR(1-5)	Emission rate (g/s) for pollutants 1-5 (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-). Leave field blank for secondary pollutants with zero emission rates.

The following 'NOZONE' cards are included only if MO3 = 1.

Columns	Type	Variable	Description
1-5	REAL ARRAY ELEMENT	XO3	X-coordinate of ozone station (in meteorological grid units).
6-10	REAL ARRAY ELEMENT	YO3	Y-coordinate of ozone station (in meteorological grid units).

CARD GROUP 14 - POINT SOURCE DATA. 'NPTS' cards required - one for each point source

Columns	Type	Variable	Description
1-5	REAL ARRAY ELEMENT	XSTAK	X-coordinate of point source (in meteorological grid units).
6-10	REAL ARRAY ELEMENT	YSTAK	Y-coordinate of point source (in meteorological grid units).
11-15	REAL ARRAY ELEMENT	HTSTAK	Stack height (m).
16-20	REAL	D	Stack diameter(m).
21-25	REAL	W	Exit velocity (m/s).
26-30	REAL ARRAY ELEMENT	TSTAK	Stack gas temperature (°K).
31-80 (5F10.2)	REAL ARRAY ELEMENT	EMIS(1-5)	Emission rate (g/s) for pollutants 1-5 (SO_2, $SO_4^=$ NO_x, HNO_3, NO_3^-). Emission rates for secondary pollutants (e.g., HNO_3, NO_3^-) are zero. Leave field blank if emission rate is zero.

CARD GROUP 13 - Continued

The following two cards are included only if MSOX=1.

Columns	Type	Variable	Description
1-80 (16F5.2)	REAL ARRAY ELEMENTS	RUSER (1-16,1)	User-supplied hourly SO_2 loss rates (%/hour) for hours 1-16.
1-40 (8F5.2)	REAL ARRAY ELEMENTS	RUSER (17-24,1)	User-supplied hourly SO_2 loss rates (%/hour) for hours 17-24.

The following four cards are included only if MNOX = 1.

Columns	Type	Variable	Description
1-80 (16F5.0)	REAL ARRAY ELEMENTS	RUSER (1-16,2)	User-supplied hourly NO_x loss rates (%/hour) for hours 1-16.
1-40 (8F5.0)	REAL ARRAY ELEMENTS	RUSER (17-24,2)	User-supplied hourly NO_x loss rates (%/hour) for hours 17-24.
1-80 (16F5.0)	REAL ARRAY ELEMENTS	RUSER (1-16,3)	User-supplied hourly total NO_3^- formation rates (%/hour) for hours 1-16.
1-40 (16F5.0)	REAL ARRAY ELEMENTS	RUSER (17-24,3)	User-supplied hourly NO_3^- formation rates (%/hour) for hours 17-24.

The following card is included only if MO3 = 1

Columns	Type	Variable	Description
1-5	INTEGER	NOZONE	Number of hourly ozone stations. NOZONE $\leq$ 15.

CARD GROUP 13 - CHEMICAL PARAMETERS (Option - included only if IOPTS(6) = 1).

Columns	Type	Variable	Default	Description
1-5	INTEGER	MSOX	2	SO_x transformation method flag. 0 = no transformation, 1 = user specified, 2 = ERT theoretical equation, 3 = Gillani Equation, 4 = Henry equation for St. Louis, 5 = Henry Equation for Los Angeles (See Section 2.3.6).
6-10	INTEGER	MNOX	2	NO_x transformation method flag. See 0 = no transformation, 1 = user specified, 2 = ERT theoretical equation. (See Section 2.3.6).
11-15	INTEGER	MO3	0	O_3 hourly input option. If MO3 = 1, hourly ozone values are required at 'NOZONE' stations. If MO3 = 0, a default ozone value (CO3B) is assumed.
16-20	REAL	CO3B	80	Default background ozone concentration (ppb). CO3B is used if MO3 = 0 or if MO3 = 1 and hourly values are missing.
21-25	REAL	CTNH3	10	Background ammonia concentration (ppb).
26-30	REAL ARRAY ELEMENT	RNITE(1)	0.2	Nighttime SO_2 loss rate (%/hour).
31-35	REAL ARRAY ELEMENT	RNITE(2)	2.0	Nighttime NO_x loss rate (%/hour).
36-40	REAL ARRAY ELEMENT	RNITE(3)	2.0	Nighttime HNO_3 formation rate (%/hour).

CARD GROUP 11 - OTHER DRY DEPOSITION CONSTANTS. (Optional - included only if IOPTS(4) = 1).

Columns	Type	Variable	Default	Description
1-10	REAL ARRAY ELEMENT	RCNOX(1)	130.	NO_x canopy resistance (s/m)* for stability classes A-C.
11-20	REAL ARRAY ELEMENT	RCNOX(2)	500.	NO_x canopy resistance (s/m) for stability class D.
21-30	REAL ARRAY ELEMENT	RCNOX(3)	1500.	NO_x canopy resistance (s/m) for stability class E.
31-40	REAL ARRAY ELEMENT	RCNOX(4)	1500.	NO_x canopy resistance (s/m) for stability class F.
41-50	REAL	RSGCON	2.6	Surface resistance contant for gases (SO_2, NO_x, HNO_3).
51-60	REAL	RSPART	1000.	Surface resistance (s/m) for particulates $SO_4^=$, NO_3^-).

CARD GROUP 12 - WET REMOVAL PARAMETERS. (Optional - included only if IOPTS (5) = 1). Two input cards required.

Columns	Type	Variable	Default	Description
1-50 (5F10.2)	REAL ARRAY ELEMENTS	WA(1-5,1)	**	Values of λ Equation 2-77 for liquid precipitation for pollutants 1-5, respectively (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-).
1-50 (5F10.2)	REAL ARRAY ELEMENTS	WA(1-5,2)	**	Values of λ in Equation 2-77 for frozen precipitation for pollutants 1-5, respectively.

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*Note: Resistance Units are s/m not s/cm.

**See Table 9 for default values.

MESOPUFF II INPUTS

CARD GROUP 9 - VERTICAL DIFFUSIVITY CONSTANTS. (Optional - included only if IOPTS (2) = 1)

Columns	Type	Variable	Default	Description
1-10	REAL	CON1K	0.01	Vertical dispersion constant, k_1, for stable conditions (Equation 2-64).
11-20	REAL	CON2K	0.10	Vertical dispersion constant, k_2, for convective conditions (Equation 2-65).

CARD GROUP 10 - SO_2 CANOPY RESISTANCES. (Optional - included only if IOPTS (3) = 1). Twelve input cards required.

Columns	Type	Variable	Default	Description
1-40 (4F10.2)	REAL ARRAY	RCSO2(12,4)	**	SO_2 canopy resistances, r_c (SO_2), in s/m.* Four values on each card for stability classes (1)A-C, (2)D, (3)E, and (4)F. Twelve cards required, for land use categories 1-12. Entered in order of increasing numerical land use category.

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*Note: Resistance Units are s/m not s/cm.

**See Table 8 for default values.

MESOPUFF II INPUTS

CARD GROUP 8 - DISPERSION PARAMETERS (Optional-included only if IOPTS(1) = 1). Six input cards required.

Columns	Type	Variable	Default	Description
1-60 (6F10.5)	REAL ARRAY	AY(6)	*	Array of horizontal dispersion coefficients, a_y, in Equation 2-32 for stability classes A-F, respectively.
1-60 (6F10.5)	REAL ARRAY	BY(6)	*	Array of horizontal dispersion coefficients, b_y, in Equation 2-32 for stability classes A-F, respectively.
1-60 (6F10.5)	REAL ARRAY	AZ(6)	*	Array of vertical dispersion coefficients, a_z, in Equation 2-33, for stability classes A-F, respectively.
1-60 (6F10.5)	REAL ARRAY	BZ(6)	*	Array of vertical dispersion coefficients, b_z, in Equation 2-33, for stability classes A-F, respectively.
1-60 (6F10.5)	REAL ARRAY	AZT(6)	*	Array of time-dependent vertical dispersion coefficients, a_{zt}, in Equation 2-37, for stability classes A-F, respectively.
1-10	REAL	TMDEP	100,000	Distance (in meters) beyond which the time dependent Equations (2-36)-(2-37) are used to determine σ_y, σ_z.
11-20	INTEGER	JSUP	5	Stability class used to determine growth rates for puffs above the boundary layer. JSUP = 5 for E stability rates, JSUP = 6 for F stability rates, JSUP = 0 for boundary layer stability rates.

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*See Tables 6, 7 for default values.

MESOPUFF II INPUTS

CARD GROUP 7 - DEFAULT OVERRIDE OPTIONS (continued)

Columns	Type	Variable	Description
6	INTEGER ARRAY ELEMENT	IOPTS(6)	Control variable for input of chemical transformation method flags and other chemical variables. See Card Group 13 for a complete description of the inputs. If IOPTS(6) = 1, the user must input values of these parameters. If IOPTS(6) = 0, the default values are used.

MESOPUFF II INPUTS

CARD GROUP 7 - DEFAULT OVERRIDE OPTIONS

Columns	Type	Variable	Description
1	INTEGER ARRAY ELEMENT	IOPTS(1)	Control variable for input of dispersion parameters. If IOPTS(1) = 1, the user must input values of the following parameters related to dispersion; a_y, b_y, a_z, b_z, a_{zt}, T_m, JSUP (see Section 2.3.1 for definitions). If IOPTS(1) = 0, the default values for the parameters are used.
2	INTEGER ARRAY ELEMENT	IOPTS(2)	Control variable for input of vertical diffusivity constants. Used only if L3VL = T. If IOPTS(2) = 1, the user must input values for the constants k_1, and k_2 of Equations (2-64)-(2-65). If IOPTS(2) = 0, the default values of $k_1 = 0.01$ and $k_2 = 0.10$ are used.
3	INTEGER ARRAY ELEMENT	IOPTS(3)	Control variable for input of SO_2 canopy resistances. Used only if LDRY = T. If IOPTS(3) = 1, the user must input SO_2 canopy resistances (r_c) for the stability\land use categories in Table 8. If IOPTS(3) = 0, the default values contained in the table are used.
4	INTEGER ARRAY ELEMENT	IOPTS(4)	Control variable for input of other dry deposition parameters. Used only if LDRY = T. If IOPTS(4) = 1, the user must input values for r_c (NO_x), r_g (gases), and r_g (particles) (see Card Group 11). If OPTS(4) = 0, the default values of these parameters are used.
5	INTEGER ARRAY ELEMENT	IOPTS(5)	Control variable for inputs of wet removal parameters. Used only if LWET = T. If IOPTS(5) = 1, the user must input values for λ (see Table 9). If IOPTS(5) = 0, the default values contained in the table are used.

When the user has defined a base case and test case concentration field (or set of fields), line printer plots or gridded tables of the following fields may be produced:

- the base field, identified as BF,
- the test field, identified as TF,
- the difference field, identified as DF = $C_B - C_T$,
- the fractional difference field identified as FDF = $\frac{C_B - C_T}{C_B}$, and
- the weighted difference field identified as WDF = $\frac{C_B - C_T}{\bar{C}_B}$

where C_B is the base field concentration at a particular grid point, C_T is the test field concentration at that point, and C_B is defined below.

The fractional difference field FDF can be calculated only for grid points with nonzero base field concentrations, but because the FDF is most meaningful in comparing base case and test case plumes which overlap exactly or nearly exactly, the FDF is calculated only for those points in the intersection of the two plumes (that is $C_B = 0$ and $C_T = 0$)

The WDF is the difference field weighted by the average base plume concentration (C_B).

$$\bar{C}_B = \frac{\sum_{n=1}^{N} (C_B)_n}{N}$$

where N includes only those points in the base field plume (defined as the set of points in the base field with nonzero concentrations).

In addition to line printer plots of the DF, FDF, and WDF, subroutine STAT has the ability to write these fields to the MESOFILE II direct access

When the user has defined a base case and test case concentration field (or set of fields), line printer plots or gridded tables of the following fields may be produced:

- the base field, identified as BF,
- the test field, identified as TF,
- the difference field, identified as DF = $C_B - C_T$,
- the fractional difference field identified as FDF = $\frac{C_B - C_T}{C_B}$, and
- the weighted difference field identified as WDF = $\frac{C_B - C_T}{\bar{C}_B}$

where C_B is the base field concentration at a particular grid point, C_T is the test field concentration at that point, and $\bar{C}_B$ is defined below.

The fractional difference field FDF can be calculated only for grid points with nonzero base field concentrations, but because the FDF is most meaningful in comparing base case and test case plumes which overlap exactly or nearly exactly, the FDF is calculated only for those points in the intersection of the two plumes (that is $C_B = 0$ and $C_T = 0$)

The WDF is the difference field weighted by the average base plume concentration ($\bar{C}_B$).

$$\bar{C}_B = \frac{\sum_{n=1}^{N} (C_B)_n}{N}$$

where N includes only those points in the base field plume (defined as the set of points in the base field with nonzero concentrations).

In addition to line printer plots of the DF, FDF, and WDF, subroutine STAT has the ability to write these fields to the MESOFILE II direct access must contain the same number of concentration arrays. The other NAMELIST inputs are the same as the subroutine ADD1 inputs. The following are sample card inputs.

- Sample Input--Example 7

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=6,NUNIT=10&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=6,NUNIT=11&END
ADD2
 &SAME IRUN1=1,IRUN2=2,DISK=1,PLOT=1,&END
```

The call to subroutine DEFN requests that disk output start on record 50 of disk File 25. Six output files of two MESOPUFF runs are defined as Runstreams 1 and 2 with the calls to subroutine FIND. The arrays of each runstream are added together, printed, written to disk, and plotted with the default contour levels. The summary process with the two 6-array runstreams results in an output runstream of 6 arrays.

3.4.7 Subroutine STAT

Subroutine STAT is designed to produce quantitative as well as qualitative measures of the point-by-point and bulk differences between two gridded concentration fields--a 'base' field and a 'test' or 'perturbed' field. The base concentration fields are reference fields resulting from a particular model run specified by the user. The test concentration fields can be any other model output generated with some test parameter of the model varied; for example, the emission inventory, deposition velocity, decay rate, time step, or even the mesoscale model used, may be varied and the results defined as the test concentration fields.

The following are sample card inputs.

- Sample Input--Example 6

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
SEEK
 &SAME NSTART=1,NSTOP=6,&END
SEEK
 &SAME NSTART=20,NSTOP=22,&END
ADD1
 &SAME IRUN=1,DISK=1,&END
ADD1
 &SAME IRUN=2,INIT=0,DISK=1,&END
```

The call to subroutine DEFN requests that the disk output of this MESOFILE II run begin at record 50 on disk File 25. Two runstreams are defined: a six array runstream (Number 1) and a three array runstream (Number 2). The first call to ADD1 sums the data in Runstream Number 1 (Records 1 to 6) and prints the result on the line printer and record 50. The second ADD1 call, because INIT = 0, adds the array in Runstream Number 2 to the summed array calculated in the first ADD1 call, and the result is also written on disk (Record 51) and on the line printer.

3.4.6 Subroutine ADD2

Subroutine ADD2 calculates the sum of arrays in two runstreams. That is,

$$D^k_{ij} = A^k_{ij} + B^k_{ij}$$

where the summation extends over all k = 1...N arrays in runstreams A and B, and D is the resultant runstream. Two runstream numbers must therefore be supplied to subroutine ADD2 as input, and both runstreams average from the data in Runstream 2. Only two output options are invoked: line printer plot and disk output. The disk output is routed to Record 54 because the previous AVRG call put arrays into Records 50 to 53. The contour levels of the line printer plot will be the same as in the previous AVRG call; when new contour levels are defined (as in the first AVRG call), the plotting routine will continue to use them until other contour levels are redefined in a DIFF NAMELIST (see Section 3.4.9). All the parameters in NAMELIST SAME that have default values are reset to their default values each time the subroutine is called. The third AVRG call uses Runstream Number 2 data to calculate three 10-array averages. The output options are the same as with the second AVRG call, and the disk output is stored on Records 55 to 57 of File 25.

3.4.5 Subroutine ADDI

Subroutines ADDI is used to sum all the arrays in a runstream to yield a single summed output array. That is,

$$(C_{sum})_{ij} = \sum_{k=1}^{N} C_{ij}^{k}$$

where $(C_{sum})_{ij}$ is the (i,j) element of the summed array, and (C_{ij}^{k}) is the (i,j) element of the k^{th} array in the consisting of N arrays (k = 1...N). The output options include an echo of the input arrays, line printer gridded output, line printer plots, and disk output and are the same as those in subroutine AVRG. The adjustment factors a and b for the summed concentration field are also available. Each call to subroutine ADDI will initialize the output array to zero before adding to it sequentially the concentration arrays of the specified runstream, unless the INIT variable is set to zero in the ADDI input NAMELIST. With INIT = 0, a cumulative sum can be calculated with successive ADDI calls.

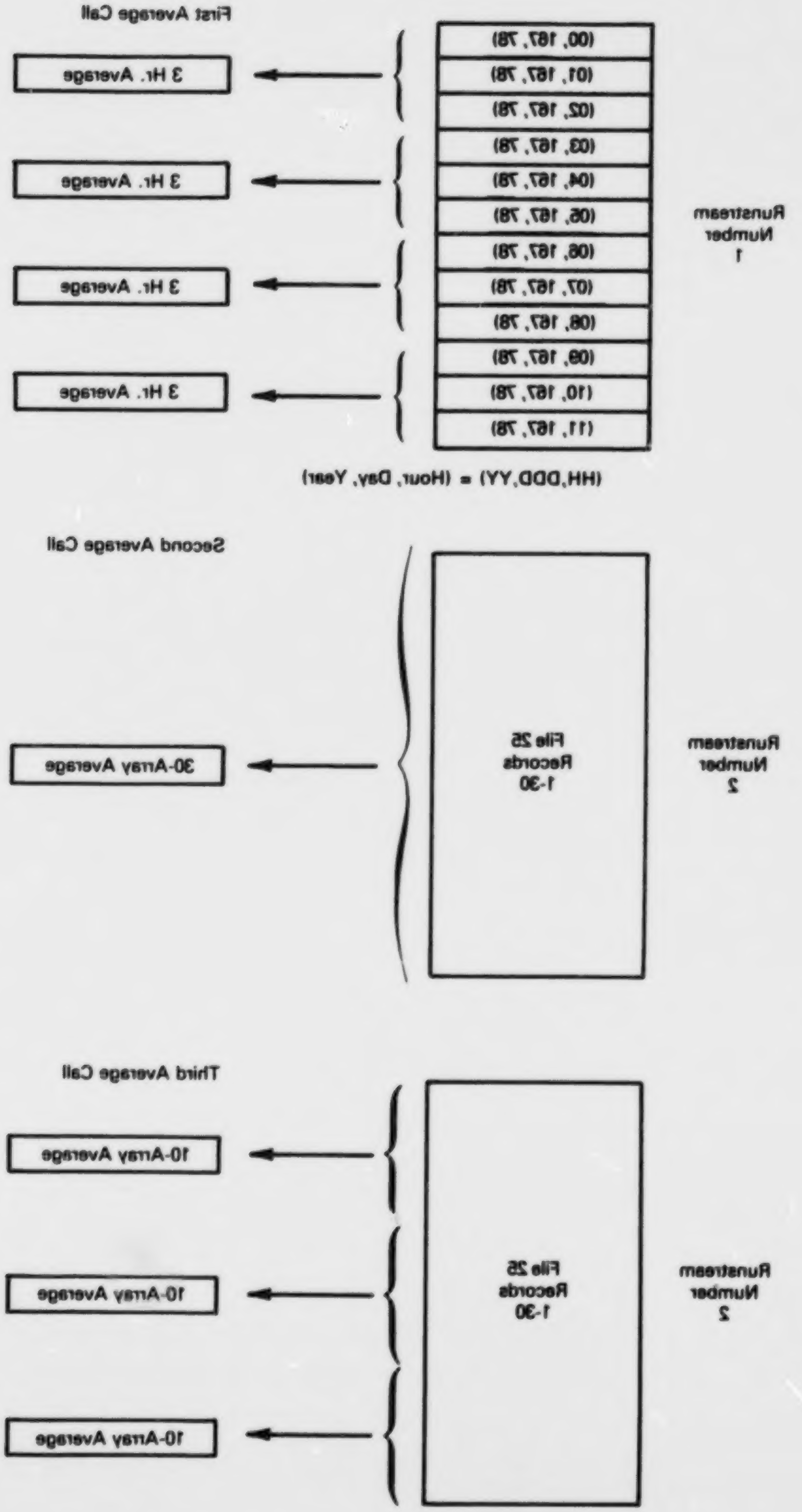

First Average Call
Runstream Number 1
(00, 167, 78)
(01, 167, 78)
(02, 167, 78)
(03, 167, 78)
(04, 167, 78)
(05, 167, 78)
(06, 167, 78)
(07, 167, 78)
(08, 167, 78)
(09, 167, 78)
(10, 167, 78)
(11, 167, 78)
3 Hr. Average
3 Hr. Average
3 Hr. Average
3 Hr. Average
(HH,DDD,YY) = (Hour, Day, Year)
Second Average Call
Runstream Number 2
File 25 Records 1-30
30-Array Average
Third Average Call
Runstream Number 2
File 25 Records 1-30
10-Array Average
10-Array Average
10-Array Average

Figure 11 Schematic Illustration of the Averaging Process

The location of all MESOFILE II disk output (File 25) is controlled by the IOUT variable of subroutine DEFN. The first output grid is written on record IOUT of file 25, the next grid is written on record IOUT + 1, etc. The user specifies the location where the disk output is to start; the disk file pointer is incremented each time a grid is written to disk. The following are sample card inputs.

- Sample Input--Example 5

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
FIND
 &SAME IYEAR=78,IDAY=167,IHOUR=0,IGRIDS=12,NUNIT=10&END
SEEK
 &SAME NSTART=1,NSTOP=30,&END
AVRG
 &SAME IRUN=1,AVETM=3,DISK=1,PLOT=1,NEWV=1,APE=1,&END
 &DIFF N=5,THR=-1.E-10,0.1E-6,1.E-6,10.E-6,100.E-6,20*0.0,&END
AVRG
 &SAME IRUN=2,AVETM=30,PRINT=0,DISK=1,PLOT=1,&END
AVRG
 &SAME IRUN=2,AVETM=10,PRINT=0,DISK=1,PLOT=1,&END
```

The call to subroutine DEFN sets the disk output pointer IOUT to 50. The averaged concentration arrays written to disk, therefore, will occupy records 50 through 50 + n on File 25, where n is the number of arrays output to disk. Subroutine FIND is called to define a 12-array runstream consisting of hourly concentration fields, as illustrated schematically in Figure 11. Runstream Number 2 is defined as the higher order data on records 1-30 of File 25. The first call to subroutine AVRG averages the data defined by Runstream 1 into four 3-hour averaged arrays. The maximum output available to the user is requested. The hourly concentration input fields and the averaged fields are printed. The averaged fields are also plotted (with user input contour levels) and written to disk (on records 50-53). The second call to subroutine AVRG results in one 30-array

```
SEEK
 &SAME NSTART=12,NSTOP=12,&END
SEEK
 &SAME NSTART=10,NSTOP=23,&END
```

As in the previous example, Runstream Number 1 is defined as a set of 24 hourly, first order concentration arrays. Runstreams 2 and 3, however, are composed of higher order data fields. The second runstream consists of a single data field (record 12 on file 25), whereas Runstream 3 is defined to be the 14 data arrays contained in records 10 through 23.

3.4.4 Subroutine AVRG

Subroutine AVRG calculates time averages of first order or higher order concentration data. This subroutine performs the following operations:

- initializes NAMELIST SAME parameters to default values,
- reads user inputs,
- calculates number of arrays in the runstream specified by the user and determines a repetition factor, IREPF,
- for each array in the runstream, reads array and if requested, prints the input array and sums arrays,
- after AVETM arrays have been read and summed, divides by AVETM to obtain average, and performs linear scaling calculation, and
- if requested, writes averaged array to disk (File 25), writes averaged array on line printer, and plots averaged array.

The user has the option of printing, plotting, or writing the averaged arrays to disk File 25. The user specifies the runstream number of the data set to be averaged and the averaging frequency (in terms of arrays), so that the appropriate block averages will be computed. A background concentration factor or a concentration multiplicative scaling factor may be included in the calculations as well. Each averaged array may be adjusted by the form:

$$\bar{C}_{ADJ} = a * \bar{C} + b.$$

3.4.3 Subroutine SEEK

Each set of data to be accessed by the data processing subroutines of MESOFILE II must be located and assigned a runstream number. The concentration data, output directly by the models to disk, are referred to as "first" order data fields and are located by calls to subroutine FIND. MESOFILE II, however, has the ability to process first order data and output the resultant fields (e.g., averaged concentration fields, summed concentration fields, or several types of concentration difference fields), to disk File 25 for storage and further processing. These derived fields, which have undergone at least one level of MESOFILE II processing, are referred to as "higher" order data fields. The user wishing to reference higher order data must supply the location (File 25 record number) of the data to MESOFILE II by a call to subroutine SEEK.

Subroutine SEEK performs the following operations:

- reads user inputs to identify the MESOFILE II output of interest:
  - NSTART and
  - NSTOP and
- defines the requested set of data fields as runstream number n, where n = 1 (first call of FIND/SEEK), n = 2 (second call of FIND/SEEK), etc.

The card input requirements of subroutine SEEK and other MESOFILE II Subroutines are described in Section 3.4.9. The following are sample card inputs.

- Sample Input--Example 4

```
TITLE CARD
FIND
&SAME IYEAR=78,IDAY=166,IHOUR=1,IGRIDS=24,NUNIT-10&END
```

subroutines. FIND is one of two runstream defining subroutines (subroutine SEEK is the other). The first set of concentration fields located by FIND (or SEEK) is referred to as Runstream 1, the second set of concentration fields defines Runstream 2, etc.

Because subroutine FIND is used to locate the output of any previously run model, it must be called before an attempt is made to process these data subsequently with any the MESOFILE II data processing subroutines. <u>Before any MESOFILE II data processing subroutines of MESOFILE II are called, subroutines FIND and SEEK must be used to locate all the model output.</u> The following are sample card inputs.

- Sample Input--Example 3

```
TITLE CARD
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,ICRIDS=24,NUNIT=10,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,ICRIDS=120,NUNIT=11,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,ICRIDS=120,NUNIT=12,&END
```

In Example 3, the concentration data referenced by Logical Unit 10 is a MESOPUFF II run starting at Hour 0, Day 165, Year 78. Because the model outputs concentration arrays at the conclusion of a time step, the first concentration array recorded is for Hour 1 on Day 165. The sample input above specifies Runstream 1 as consisting of 24 hourly concentration arrays, starting at Hour 1, Day 165 and ending at Hour 0, Day 166. The second call to subroutine FIND defines Runstream 2 as the set of concentration arrays output from Logical Unit 11 starting at Hour 1, Day 165, through Hour 0, Day 170. Runstream Number 3 is specified as the output from the Logical Unit 12 for the same 120-hour time period.

```
DEPN
 &SAME IMAX=40,JMAX=40,IOUT=1,&END
```

- Sample Input--Example 2B

```
TITLE CARD
DEPN
 &SAME IPOL=2,IOUT=20,&END
```

The call to subroutine DEPN in Example 2A sets the concentration array size to 40 x 40. The disk file output pointer, IOUT, is given a value of 1. Any disk output that may be generated later in the MESOFILE II run, therefore, will start on Record 1 of File 25. In Example 2B, $SO_4^{=}$ is specified as the pollutant of interest. The disk output of this MESOFILE II run will begin on Record 20. The concentration array size is assumed (by default) to be 26 x 26.

3.4.2 Subroutine FIND

Subroutine FIND performs the following operations:

- reads user inputs to identify the model output to be located:
  - starting hour, day, and year of data
  - number of concentration fields
  - logical unit of concentration data;
- reads the header record of the new concentration file;
- finds the proper position in the file correspondence in the starting hour; and
- defines the requested set of concentration arrays as runstream number n, where n = 1 (first call of FIND/SEEK), n = 2 (second call of FIND/SEEK), etc.

Each call to subroutine FIND defines a runstream (i.e., one or a group of concentration fields) that can be accessed by other MESOFILE II subroutines. A runstream number is a sequential internal reference number associated with a group of concentration arrays located by subroutine FIND or SEEK and is used to identify these arrays in other MESOFILE II

Although a MESOPUFF II run may generate concentration data for up to five pollutants, only one pollutant (default = SO_2) is processed at a time by MESOFILE II. The concentration array size, IMAX * JMAX, must be the same as the sampling grid size specified in the MESOPUFF II model run used to generate the concentration data.

All MESOFILE II disk output (concentration fields, difference fields, etc.) is written to the MESOFILE II output File 25. Each output field requires one record of disk space on File 25. The user must specify the record where the disk output is to start for a particular MESOFILE II run. The first output array is written at this record; the second output array is written at the next record, etc. Each time an array is written to disk, the disk file pointer is incremented by one. A particular MESOFILE II run, for example, may write n concentration arrays on Records 1 through n; the user may wish to save this output, and, on a subsequent MESOFILE II run, the output may be directed to begin at record n+1.

The starting record number for MESOFILE II disk output is not supplied with a default value; this helps prevent accidental overwriting of previously stored data. The user must specify this parameter if the MESOFILE II run is to generate any disk output. The concentration array size and pollutant are used in block data; subroutine DEFN must therefore be called only if:

- any disk output is generated in the MESOFILE II run,
- the concentration array size is different from the default 26 x 26, or
- the pollutant of interest is not SO_2.

A description of the card inputs to each MESOFILE II subroutine is contained in Section 3.4.9. The following are sample card inputs.

- Sample Input--Example 2A
  TITLE CARD

before the subroutines in Group C. At the end of the run, subroutine DECODE is automatically called as part of the normal termination of MESOFILE II. DECODE gives a useful summary of all the subroutines called, the values of the input parameters, the input/output options, and the locations (record numbers) of the MESOFILE II disk output (on File 25) for this MESOFILE II run.

As indicated in Table 14, following a title card and the subroutine identifier card is the NAMELIST card containing the necessary input data. In FORTRAN NAMELIST formatted inputs, the first character of each input record must be a blank, followed by an & and the NAMELIST name. The input data, separated by commas, must appear between the NAMELIST name and an &END. All the NAMELIST names in MESOFILE II are either "SAME" (in subroutines called by the user via subroutine identifier cards) or "DIFF" (in the line printer plotting subroutines).

The following sections contain a detailed description of the functions, the required inputs, and the output options of each MESOFILE II subroutine. Annotated sample inputs follow each subroutine description to demonstrate each of the options available to the user. Sample inputs for the most common applications of MESOFILE II are presented in Section 3.4.8

3.4.1 Subroutine DEFN

Subroutine DEFN allows the user to specify for a particular MESOFILE II run:

- the concentration grid size,
- the pollutant of interest (SO_2, $SO_4^=$ NO_x, HNO_3, NO_3^-),
- receptor type processed in this run (gridded or non-gridded receptors),
- the starting record of the disk output on the MESOFILE II disk file (File 25).

TABLE 14. MESOFILE II CARD-IMAGE INPUTS AND SUBROUTINE IDENTIFIERS

MESOFILE II CARD INPUTS

- TITLE CARD

  Up to 64 characters (columns 1-64) (followed by one set of cards as specified below for each subroutine requested by the user)

- SUBROUTINE IDENTIFIER CARD

  Contains 4-letter subroutine identifier (in Columns 1-4)

- NAMELIST INPUT CARD #1

  Read by the subroutine called

- NAMELIST INPUT CARD #2

  Read by the line printer plotting routine (needed only if line printer plots are produced and contour levels other than the default contour levels are used).

SUBROUTINE IDENTIFIER	CALLING ORDER GROUP	SUBROUTINE FUNCTION (see detailed subroutine descriptions - Sections 3.4.1-3.4.7
• DEFN	A	Defines Pollutant, Grid Size, and Routes Output
• FIND	B	Locates First Order Model Output
• SEEK	B	Locates Higher Order MESOFILE II Output
• AVRG	C	Averages Arrays
• ADD1	C	Sums Arrays within one runstream
• ADD2	C	Sums Arrays from two runstreams
• STAT	C	Calculates Statistics

MESOFILE II INPUTS

CARD INPUTS TO SUBROUTINE SEEK

SUBROUTINE SEEK

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
NSTART	INTEGER	Starting disk record number on File 25 of the output of interest.	-
NSTOP	INTEGER	Ending disk record number on File 25 of the output of interest.	-

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE FIND

SUBROUTINE FIND

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IHOUR	INTEGER	Ending hour of the first concentration array of interest.	-
IDAY	INTEGER	Day number of the first concentration array of interest.	-
IYEAR	INTEGER	Year of the first concentration array of interest.	-
IGRIDS	INTEGER	Number of concentration arrays.	-
NUNIT	INTEGER	Logical unit number of concentration data	-

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE DEPN

SUBROUTINE DEPN

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IPOL	INTEGER	Pollutant (IPOL = 1-5 for SO_2, $SO_4^=$, NO_x, HNO_3 and NO_3^-, respectively)	1
IRTYPE	INTEGER	Receptor type (IRTYPE=1 for gridded receptors, IRTYPE=2 for non-gridded receptors).	1
IMAX	INTEGER	Number of elements of the concentration array in the X direction (≤ 40).	26
JMAX	INTEGER	Number of elements of the concentration array in the Y direction (≤ 40).	26
IOUT	INTEGER	Record number of File 25 at which MESOPILE II disk output is to start.	-

of the concentration fields reflecting the effects of the sources modeled in two runs)

```
TITLE CARD
DEFN
 &SAME IOUT=11,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=24,NUNIT=10&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=24,NUNIT=11&END
ADD2
 &SAME IRUN1=1,IRUN2=2,PRINT=0,PLOT=1,&END
```

3.4.9 MESOFILE II Run Control Parameter Descriptions

A complete description of the run control inputs to each MESOFILE II subroutine is contained in the following pages.

previous STAT call; when new contour levels are defined (in the DIFP NAMELIST), they become the "default" contour levels for subsequent calls to the plotting routine. The difference fields are written to disk File 25 on Records 54 to 57.

3.4.8 Sample Card Inputs for Some Useful MESOFILE II Applications

- Calculate 24-hour SO_2 averages from hourly output of two model runs; write results on disk

```
TITLE CARD
DEFN
 &SAME IOUT=1,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=10&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=11&END
AVRG
 &SAME IRUN=1,AVETM=24,DISK=1,&END
AVRG
 &SAME IRUN=2,AVETM=24,DISK=1,&END
```

- Perform statistical analysis of the 24-hour average concentrations calculated for two model runs in example above

```
TITLE CARD
SEEK
 &SAME NSTART=1,NSTOP=5,&END
SEEK
 &SAME NSTART=6,NSTOP=10,&END
STAT
 &SAME IND1=1,IND2=2,&END
```

- Calculate and plot sums of the hourly SO_2 output of two model runs (useful for runs made with different subsets of the entire source inventory; the resulting horizontal sum is a superposition

It is possible to write DF, FDF, or WDF to the MESOFILE II direct access disk output file (File 25), although only one of these fields can be written on a particular call to STAT.

The following are sample card inputs.

- Sample Input--Example 8

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
SEEK
 &SAME NSTART=9,NSTOP=12,&END
SEEK
 &SAME NSTART=19,NSTOP=22,&END
SEEK
 &SAME NSTART=28,NSTOP=32,&END
STAT
 &SAME IND1=1,IND2=2,DISKD=1,PLOTD=1,NEWVD=1,&END
 &DIFF THR=-100.E-6,-5.E-6,-1.E-6,-.5E-6,-1.E-15,0,1.E-15,
 .5E-6,1.E-6,5.E-6,15*0.0,N=10,&END
STAT
 &SAME IND1=1,IND2=3,DISKD=1,PLOTD=1,&END
```

In this example, the call to subroutine DEFN requests that the disk output of this MESOFILE II run start at Record 50 of disk File 25. Three runstreams are defined by calls to subroutines SEEK, each consisting of four arrays. The first call to STAT results in four sets of statistics; each array of Runstream 1 is compared to the corresponding array of Runstream 2. The fields associated with the runstream identified with IND1 are defined to be the base case fields; IND2 defines the test case fields. The difference fields are plotted with the user-specified contour levels in the DIFF NAMELIST, and they are written to disk File 25 (on Records 50 to 53). The second call to STAT will produce statistics comparing the arrays in Runstream 1 (base case) to the arrays in Runstream 3 (test case). The difference fields are plotted with the same contour levels as in the

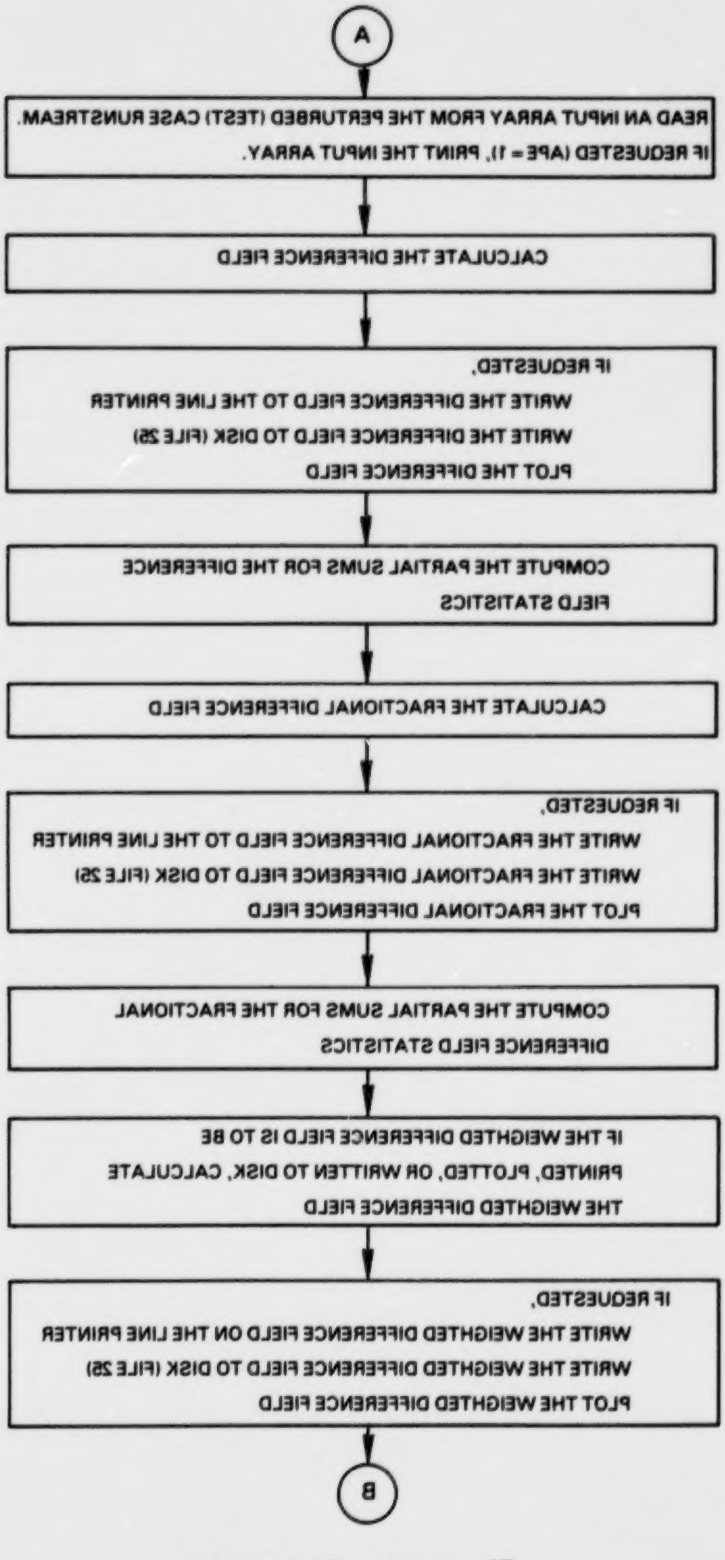

A
READ AN INPUT ARRAY FROM THE PERTURBED (TEST) CASE RUNSTREAM. IF REQUESTED (APE = 1), PRINT THE INPUT ARRAY.
CALCULATE THE DIFFERENCE FIELD
IF REQUESTED,
WRITE THE DIFFERENCE FIELD TO THE LINE PRINTER
WRITE THE DIFFERENCE FIELD TO DISK (FILE 25)
PLOT THE DIFFERENCE FIELD
COMPUTE THE PARTIAL SUMS FOR THE DIFFERENCE FIELD STATISTICS
CALCULATE THE FRACTIONAL DIFFERENCE FIELD
IF REQUESTED,
WRITE THE FRACTIONAL DIFFERENCE FIELD TO THE LINE PRINTER
WRITE THE FRACTIONAL DIFFERENCE FIELD TO DISK (FILE 25)
PLOT THE FRACTIONAL DIFFERENCE FIELD
COMPUTE THE PARTIAL SUMS FOR THE FRACTIONAL DIFFERENCE FIELD STATISTICS
IF THE WEIGHTED DIFFERENCE FIELD IS TO BE PRINTED, PLOTTED, OR WRITTEN TO DISK, CALCULATE THE WEIGHTED DIFFERENCE FIELD
IF REQUESTED,
WRITE THE WEIGHTED DIFFERENCE FIELD ON THE LINE PRINTER
WRITE THE WEIGHTED DIFFERENCE FIELD TO DISK (FILE 25)
PLOT THE WEIGHTED DIFFERENCE FIELD
B

Figure 14 Continued

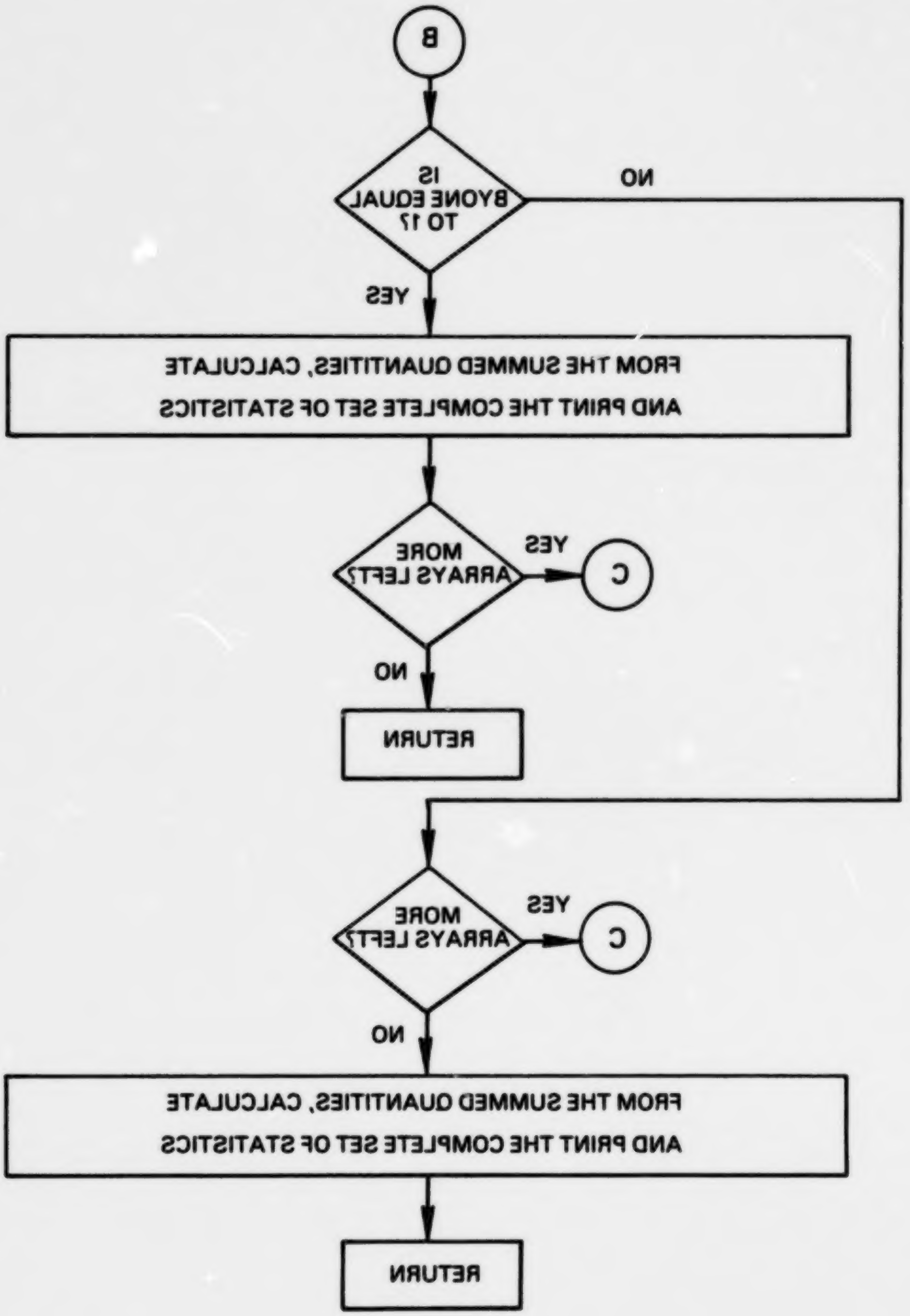

B
IS BYONE EQUAL TO 1?
NO
YES
FROM THE SUMMED QUANTITIES, CALCULATE AND PRINT THE COMPLETE SET OF STATISTICS
MORE ARRAYS LEFT?
YES
C
NO
RETURN
MORE ARRAYS LEFT?
YES
C
NO
FROM THE SUMMED QUANTITIES, CALCULATE AND PRINT THE COMPLETE SET OF STATISTICS
RETURN

Figure 14 Continued

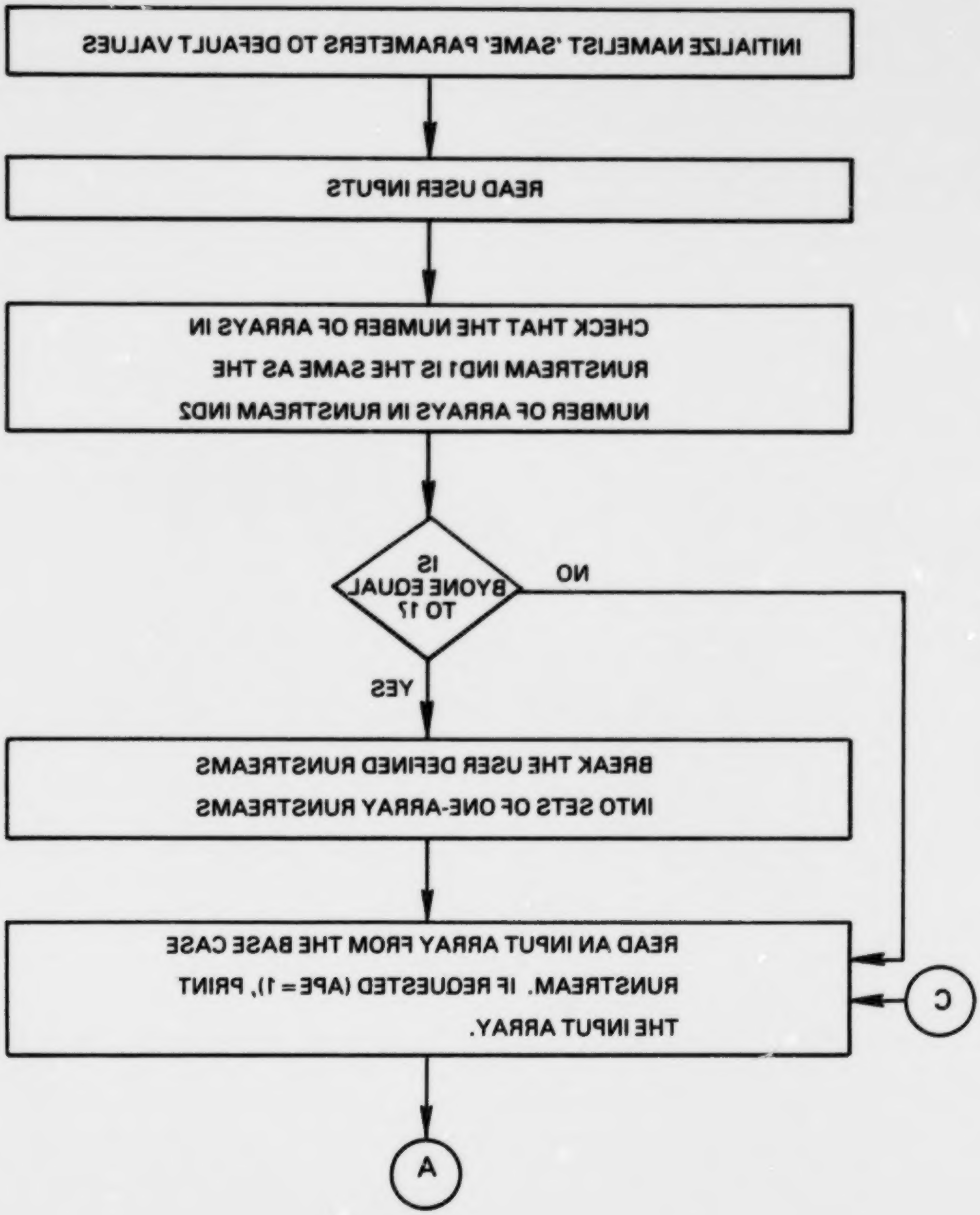
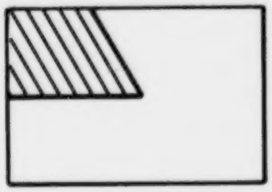
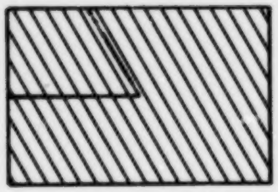

INITIALIZE NAMELIST 'SAME' PARAMETERS TO DEFAULT VALUES
READ USER INPUTS
CHECK THAT THE NUMBER OF ARRAYS IN RUNSTREAM IND1 IS THE SAME AS THE NUMBER OF ARRAYS IN RUNSTREAM IND2
IS BYONE EQUAL TO 1?
NO
YES
BREAK THE USER DEFINED RUNSTREAMS INTO SETS OF ONE-ARRAY RUNSTREAMS
READ AN INPUT ARRAY FROM THE BASE CASE RUNSTREAM. IF REQUESTED (APE = 1), PRINT THE INPUT ARRAY.
C
A

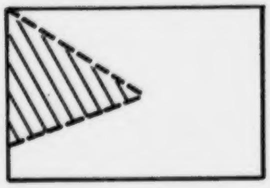
Figure 14 Flow Chart of Subroutine STAT



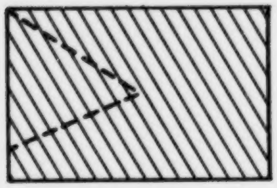
(BP) BASE PLUME ONLY



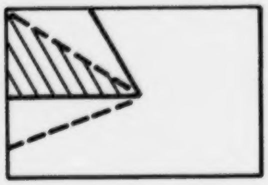
(BF) ENTIRE BASE FIELD GRID



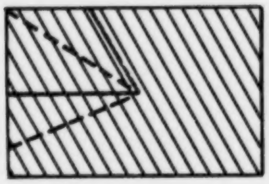
(TP) TEST PLUME ONLY



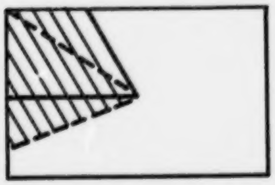
(TF) ENTIRE TEST FIELD GRID



(BTI) BASE - TEST PLUME INTERSECTION



(BFTF) BASE FIELD - TEST FIELD UNION



(BTU) BASE - TEST PLUME UNION

Figure 13 Grid Subsets Used in Statistical Calculations

TABLE 15. (Continued)

	Variable Name	Grid Points Included
13. Average fractional deviation,	AFDO	BTI
$\overline{\frac{C_B - C_T}{C_B}}$		
14. Average absolute fractional deviation	AAFDO	BTI
$\overline{\frac{C_B - C_T}{C_B}}$		
15. Maximum absolute fractional deviation,	XMLFDO	BTI
$\mathrm{MAX}\ \frac{C_B - C_T}{C_B}$		
16. Fractional deviation of the means	FDM	$\bar{X}_B$-BP
$\frac{\bar{C}_B - \bar{C}_T}{\bar{C}_B}$		$\bar{X}_T$ - TP

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TABLE 15. STATISTICAL MEASURES CALCULATED BY SUBROUTINE STAT

	Variable Name	Grid Points Included
1. Mean base plume concentration, $\bar{C}_B$	AVEBO	BP
2. Mean test (perturbed) plume concentration, $\bar{C}_T$	AVEPO	TP
3. Mean base field concentration	AVEB	BF
4. Mean test field concentration	AVEP	TF
5. Average deviation, C_B-C_T	AD	BFTF
	ADI	BTU
	ADO	BTI
6. Average absolute deviation, C_B-C_T	AAD	BFTF
	AADI	BTU
	AADO	BTI
7. Maximum local deviation, MAX (C_B-C_T)	XMLD	BFTF
8. Maximum base field value, MAX (C_B)	XMBF	BF
9. Maximum test field value, MAX (C_T)	XMPF	TF
10. Difference of maxima, MAX (C_B) - MAX (C_T)	DLM	DFTF
11. Fractional difference of maxima, $\frac{\text{MAX}(C_B) - \text{MAX}(C_T)}{\text{MAX}(C_B)}$	FDLM	BFTF
12. Correlation coefficient, $\frac{\overline{C_B C_T} - \bar{C}_B \bar{C}_T}{\overline{C_B^2} - (\bar{C}_B)^2 \quad \overline{C_T^2} - (\bar{C}_T)^2}$	RBA	BTU

Figure 12 Sample of Statistical Output

```
FRACTIONAL DEVIATION OF THE MEANS (FDM) = -0.21788E-01
AVERAGE PERTURBED PLUME VALUE (AVPPO) =  0.30952E-06
AVERAGE BASE PLUME VALUE (AVBPO) =  0.30295E-06
NUMBER OF GRID POINTS IN THE PERTURBED PLUME =       356
NUMBER OF GRID POINTS IN THE BASE PLUME =       350
NUMBER OF NON-ZERO CONCENTRATIONS (BASE OR PERTURBED) =       362
NUMBER OF GRID POINTS CONTAINED IN THE INTERSECTION OF THE BASE AND PERTURBED PLUMES =       344
TOTAL NUMBER OF GRID POINTS =       676


PLUME CHARACTERISTICS


MAXIMUM ABSOLUTE FRACTIONAL DEVIATION (XMAFDO) =  0.25661E+02
AVERAGE ABSOLUTE FRACTIONAL DEVIATION (AAFDO) =  0.61030E+00
AVERAGE FRACTIONAL DEVIATION (AFDO) = -0.33695E+00
AVERAGE ABSOLUTE DEVIATION (AADO) =  0.47060E-07
AVERAGE DEVIATION (ADO) = -0.54887E-08

STATISTICS FOR THE SET OF POINTS WITHIN THE INTERSECTION OF THE TWO PLUMES:


CORRELATION COEFFICIENT (RAV) =  0.79
AVERAGE ABSOLUTE DEVIATION (AADI) =  0.98574E-07
AVERAGE DEVIATION (ADI) = -0.11512E-07

STATISTICS FOR THE SET OF POINTS WITHIN THE UNION OF THE TWO PLUMES:


MAXIMUM PERTURBED FIELD VALUE (XMPF) =  0.10246E-04
MAXIMUM BASE FIELD VALUE (XMBF) =  0.80800E-05
FRACTIONAL DIFFERENCE OF MAXIMA (FDLM) B-P = -0.26802E+00
DIFFERENCE OF MAXIMA (DLM) B-P = -0.21656E-05
MAXIMUM LOCAL DEVIATION (XMLD) =  0.41118E-05
AVERAGE ABSOLUTE DEVIATION (AAD) =  0.52787E-07
AVERAGE DEVIATION (AD) = -0.61647E-08
AVERAGE PERTURBED FIELD VALUE (AVEP) =  0.16300E-06
AVERAGE BASE FIELD VALUE (AVEB) =  0.15684E-06


STATISTICS FOR THE SET OF ALL GRID POINTS:


FIRST RECORD =     21      LAST RECORD =     21
THE FOLLOWING RECORDS WERE USED AS THE PERTURBED FIELD:

FIRST RECORD =     46      LAST RECORD =     46
THE FOLLOWING RECORDS WERE USED AS THE BASE FIELD:
```

disk output file (File 25), so that Calcomp plots may be generated for these fields.

Variation of the test parameter can substantially change the nature of the concentration distribution in the base and test plumes; these differences in turn determine which of the difference field representations is appropriate for a particular analysis. The PDF field is useful in determining the relative spatial location of the base and test plumes and differences in the concentration distribution, and should be used when the effect of the input parameter does not change the gross spatial distribution of the plume. The WDF allows the differences in concentration to be weighted by a constant factor.

Subroutine STAT also generates a set of quantitative (statistical) measures of the differences in the base case and test case concentration fields. Whereas the graphical output is optional, the statistical output is always produced. Figure 12 is a sample of the statistical output. The statistics calculated and the subsets of the grid over which the calculations are performed are contained in Table 15 and Figure 13. Clearly, the most meaningful statistic for a given base case-test case comparison depends heavily on the nature of the test parameter varied and must be determined by the user.

F12

T15

F13

Figure 14 is a flowchart of subroutine STAT. The input variables are defined in Section 3.4.9. It is assumed that the statistics for multiarray runstreams are to be calculated on an array-by-array basis; the variable BYONE, therefore, has a default value of 1. It is possible, however, to logically concatenate successive arrays in a particular runstream by specifying BYONE = 0. For example, consider base case and test case runstreams consisting of three 24-hour averages. If BYONE = 1, array-by-array statistics (i.e., 3 sets of statistics, one set for each 24-hour averaged array) will be produced; BYONE = 0 will result in only one set of statistics over the entire 72-hour period.

F14

APPENDIX A

Table A-1. Flow Diagram for MESOPAC II

```
*  Read User Inputs

*  Write Header Record in Meteorological Output File

*  Read Starting Set of Upper Air Data (00 and 12 GMT for first day)
   (READ56 Format)

|---  *  Enter Day Loop
|
|     *  Compute Sunrise, Sunset Times, Hourly Solar
|        Elevation Angles
|
|     *  Read 24 Hours of Precipitation Data (TD9657 Format)
|
|     |---  *  Enter Hour Loop
|     |
|     |     *  Read Hourly Surface Data (CD144 Format)
|     |
|     |     *  Convert Surface Data to Proper Units, Calculate
|     |        Precipitation Codes
|     |
|     |     *  If Hour = 00 GMT, Read Next 12 GMT Sounding,
|     |        If Hour = 12 GMT, Read Next 00 GMT Sounding,
|     |        (READ56 Format)
|     |
|     |     *  Calculate Surface Wind Field at Each Grid Point
|     |
|     |     *  Calculate PGT Stability Class at Each Grid Point
|     |
|     |     *  Calculate $\overline{w'\theta'}$ at Each Grid Point
|     |
|     |     *  Calculate $u_*$ at Each Grid Point
|     |
|     |     *  Calculate $z_i$ at Each Grid Point
|     |
|     |     *  Calculate L at Each Grid Point
|     |
|     |     *  Calculate $w_*$ at Each Grid Point
|     |
|     |     *  Calculate Lower Level Wind Field at Each Grid Point
|     |
|     |     *  Calculate Upper Level Wind Field at Each Grid Point
|     |
|     |     *  Write Computed Meteorological Data to Output File
|     |
|     |---  *  End Hour Loop
|
|---  End Day Loop

*  Close Files, Terminate Run
```

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MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE STAT (Continued)

SUBROUTINE STAT

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
NEWVD	INTEGER	Plotter contour values control variable. If NEWVD = 1, user inputs contour values (if NEWV = 1, user must insert a DIFF NAMELIST card with the appropriate contour information). In NEWVD = 0, use default contour values.	0
PRINTF	INTEGER	Same as PRINTD, except for the fractional difference fields.	0
DISKF	INTEGER	Same as DISKD, except for the fractional difference fields.	0
PLOTF	INTEGER	Same as PLOTD, except for the fractional difference fields.	0
NEWVF	INTEGER	Same as NEWVD, except for the fractional difference fields.	0
PRINTW	INTEGER	Same as PRINTD, except for the weighted difference fields.	0
DISKW	INTEGER	Same as DISKD, except for the weighted difference fields.	0
PLOTW	INTEGER	Same as PLOTD, except for the weighted difference fields.	0
NEWVW	INTEGER	Same as NEWVD, except for the weighted difference fields.	0
APE	INTEGER	Controls echo of input fields If APE = 1, input fields are printed; If APE = 0, input fields are not printed.	0

MESOFILE II INPUTS

CARD INPUTS TO SUBROUTINE STAT

SUBROUTINE STAT

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IND1	INTEGER	Base case runstream number.	-
IND2	INTEGER	Perturbed (test) case runstream number.	-
BYONE	INTEGER	Determines whether multi-array runstreams are to be treated as one concatenated data set (producing one set of statistics) or as a group of one-array runstreams (producing a set of statistics for each array pair) If BYONE = 1, array by-array statistics calculated; If BYONE = 0, collective statistics calculated.	1
PRINTD	INTEGER	Line printer output control variable for the difference fields. If PRINTD = 1, difference fields are printed; If PRINTD = 0, difference fields are not printed.	0
DISKD	INTEGER	Disk output control variable for the output fields. If DISKD = 1, difference fields are written on disk; If DISKD = 0, difference fields are not written on disk.	0
PLOTD	INTEGER	Line printer plotting control variable for the difference fields. If PLOTD = 1, plots are produced; If PLOTD = 0, plots are not produced.	0

MESOFILE II INPUTS

CARD INPUTS TO SUBROUTINE ADD2 (Continued)

SUBROUTINE ADD2

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
a,b	REAL	Adjustment factors for the summed concentration fields, a=multiplicative factor b=additive factor of the form, $C_{adj} = a * C + b.$	a=1. b=0.

MESOFILE II INPUTS

CARD INPUTS TO SUBROUTINE ADD2

SUBROUTINE ADD2

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN1	INTEGER	Runstream Number 1	--
IRUN2	INTEGER	Runstream Number 2.	--
PRINT	INTEGER	Line printer output control variable. If PRINT = 1, summed arrays are printed; If PRINT = 0, summed arrays are not printed.	1
IFORM	INTEGER	Format variable for line printer output. If IFORM=1, non-gridded receptor concentrations are printed in F12.2 format. If IFORM=2, non-gridded receptor concentrations are printed in E12.5 format.	1
DISK	INTEGER	Disk output control variable. If DISK = 1, summed arrays are written on disk; If DISK = 0, summed arrays are not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If plot = 1, plots are produced; If plot = 0, plots are not produced.	0
NEW	INTEGER	In NEWV = 1, user inputs contour values (if NEWV = 1, user must insert a DIFF NAMELIST card with the appropriate contour information); If NEWV = 0, use default contour values.	0
APE	INTEGER	Controls echo of input fields. If APE = 1, input fields are printed; If APE = 0, input fields are not printed.	0

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE ADDI (Continued)

Description of Inputs to Subroutine ADDI

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
APE	INTEGER	Controls echo of input fields. If APE = 1, input fields are printed; If APE = 0, input fields are not printed.	0
a,b	REAL	Adjustment factors for the summed concentration field, a=multiplicative factor, b=additive factor, of the form, $C_{adj} = a * C + b$.	a = 1. b = 0.

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE ADD1

Description of Inputs to Subroutine ADD1

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN	INTEGER	Runstream number.	-
INIT	INTEGER	Determines whether the summing array is initialized to zero; If INIT = 1, array initialized to zero; If INIT = 0, array is not initialized.	1
PRINT	INTEGER	Line printer output control variable. If PRINT = 1, summed array is printed; If PRINT = 0, summed array is not printed.	1
IFORM	INTEGER	Format variable for line printer output. If IFORM=1, non-gridded receptor concentrations are printed in F12.2 format. If IFORM=2, non-gridded receptor concentrations are printed in E12.5 format.	1
DISK	INTEGER	Disk output control variable. If DISK = 1, summed array is written on disk; If DISK = 0, summed array is not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If PLOT = 1, plots are produced; If PLOT = 0, plots are not produced.	0
NEWV	INTEGER	Plotter contour values control variable. If NEWV = 1, user input contour values (if NEWV = 1, user must insert a DIFF NAMELIST card with the appropriate contour information); If NEWV = 0, use default contour values.	0

MESOPILE II INPUTS

CARD INPUTS TO THE LINE PRINTER PLOTTING ROUTINE

NAMELIST TITLE - DIFF

(included only for line printer plots with user input contour levels)

Parameter	Type	Definition	Default
N	INTEGER	Number of contour levels (must be ≤ 25)	9
THR(25)	REAL ARRAY	Contour values*	$-1. \times 10^{-10}$ 0.1×10^{-6} 0.5×10^{-6} 1.0×10^{-6} 2.0×10^{-6} 5.0×10^{-6} 10.0×10^{-6} 25.0×10^{-6} 50.0×10^{-6}

---

*The first element of THR should be less than the minimum value of the field being plotted.

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE AVRG (Continued)

SUBROUTINE AVRG

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
APE	INTEGER	Controls echo of input (unaveraged) fields. If APE = 1, input fields are printed; If APE = 0, input fields are not printed.	0
a,b	REAL	Adjustment factors for the averaged concentration field. a = multiplicative factor, b = additive factor, of the form, $C_{adj} = a * C + b$.	a=1. b=0.

MESOPILE II INPUTS

CARD INPUTS TO SUBROUTINE AVRG

SUBROUTINE AVRG

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN	INTEGER	Runstream number.	-
AVETM	INTEGER	Averaging time (in terms of number of arrays).	-
PRINT	INTEGER	Line printer output control variable. If PRINT =1, averaged concentration arrays are printed; If PRINT =0, averaged concentration arrays are not printed.	1
IFORM	INTEGER	Format control variable for line printer output. If IFORM=1, non-gridded receptor concentrations are printed in F12.2 format. IF IFORM=2, non-gridded receptor concentrations are printed in E12.5 format.	1
DISK	INTEGER	Disk output control variable. If DISK = 1, average concentration arrays are written on disk; If DISK = 0 averaged concentration arrays are not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If PLOT = 1, plots are produced; If PLOT = 0, plots are not produced.	0
NEWV	INTEGER	Plotter contour values control variable. If NEWV = 1, user inputs contour values (if NEWV = 1, user must insert a DIFF NAMELIST card with the appropriate contour information); If NEWV = 0, use default contour values.	0

```
  |  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
2 |  2     2     2     2     2     4     4     4     4     4     2     4     4     4     4     4     2     2     2     2     2     2     2     4
  |  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
1 |  2     2     2     2     2     4     4     4     4     4     2     4     4     4     4     4     2     2     2     2     2     2     2     4
  |  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  -----------------------------------------------------------------------------------------------------------------------------------------------
     1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20    21    22    23    24

SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **  -4

30 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  2000  3000  3000  3000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
29 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  2000  2000  2000  3000  3000  3000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
28 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  2000  3000  3000  2000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
27 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  2000  3000  3000  2000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
26 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  2000  2000  2000  3000  3000  3000  3000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
25 | 3000  3000  3000  3000  3000  2000  3000  3000  3000  3000  3000  2000  3000  3000  2000  3000  3000  3000  3000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
24 | 3000  3000  2000  3000  3000  2000  3000  3000  3000  3000  3000  2000  2000  2000  3000  3000  3000  3000  3000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
23 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
22 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
21 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
20 | 3000  3000  3000  9000  9000  3000  3000  3000  3000  9000  9000  3000  3000  3000  9000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
19 | 3000  3000  3000  9000  9000  3000  3000  3000  3000  3000  3000  3000  9000  9000  3000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
18 | 3000  3000  3000  9000  9000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
17 | 3000  3000  3000  3000  3000  3000  2000  2000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
16 | 3000  3000  3000  3000  3000  3000  2000  2000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
15 | 3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  3000  3000  3000  9000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
14 | 2000  2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  3000  3000  3000  3000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
13 | 2000  2000  3000  9000  9000  3000  3000  3000  3000  3000  3000  9000  9000  9000  3000  3000  3000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
12 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
11 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
10 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 9 | 2000  2000  3000  3000  3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 8 | 3000  3000  9000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 7 | 9000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 6 | 9000  9000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000
   |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
                    MESOPAC   VERSION 1.0   LEVEL 921201
****************************************************************************************************

LAND USE CATEGORIES FOR EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **    0

30 I 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 4 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
29 I 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 4 4 4 2 4 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
28 I 1 1 2 2 2 2 2 2 2 2 2 1 2 2 1 2 2 2 4 4 4 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
27 I 1 1 2 2 2 2 2 2 2 2 2 1 2 2 1 2 2 2 4 4 4 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
26 I 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
25 I 2 2 2 2 2 1 2 2 2 2 2 1 2 2 1 2 2 2 2 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
24 I 2 2 1 2 2 1 2 2 2 2 2 1 1 1 2 2 2 2 2 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
23 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
22 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
21 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
20 I 2 2 2 4 4 2 2 2 2 4 4 2 2 2 4 2 2 2 4 4 4 4 4 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
19 I 2 2 2 4 4 2 2 2 2 2 2 2 4 4 2 4 4 4 4 4 4 4 4 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
18 I 2 2 2 4 4 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
17 I 2 2 2 2 2 2 1 1 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
16 I 2 2 2 2 2 2 1 1 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
15 I 2 2 2 2 2 2 2 2 2 2 2 4 4 4 2 2 2 4 2 2 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
14 I 1 1 1 2 2 2 2 2 2 2 2 4 4 4 2 2 2 2 4 4 2 2 2 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
13 I 1 1 2 4 4 2 2 2 2 2 2 4 4 4 2 2 2 2 2 2 2 2 2 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
12 I 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 2 2 2 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
11 I 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 2 2 2 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
10 I 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
 9 I 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
 8 I 2 2 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
 7 I 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
 6 I 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2
   I + + + + + + + + + + + + + + + + + + + + + + + +
 5 I 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
 4 I 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 4
   I + + + + + + + + + + + + + + + + + + + + + + + +
 3 I 4 4 2 2 2 4 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 2
```

```
                                         MESOPAC   VERSION 1.0   LEVEL 821201
***************************************************************************************************************
DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)
    USER INPUT SURFACE WIND SPEED MEASUREMENT HT (ZW) IOPTS(1) = 0
    USER INPUT VON KARMAN CONSTANT (VK) IOPTS(2) = 0
    USER INPUT FRICTION VELOCITY CONSTANTS (GAMMA,CONSTV) IOPTS(3) = 0
    USER INPUT MIXING HT CONSTANTS (CONSTB,CONSTE,DELTZ,DPTMIN,CONSTN) IOPTS(4) = 0
    USER INPUT WIND FIELD VARIABLES (RADIUS,ILWF,IUWF) IOPTS(5) = 0
    USER INPUT SURFACE ROUGHNESS LENGTHS (Z0) AT EACH GRID POINT  IOPTS(6) = 0
    HEAT FLUX CORRECTED USING MIXING HT DATA ? IOPTS(7) = 0
    USER INPUT FACTORS (RETA) FOR RADIATION REDUCTION DUE TO CLOUD COVER  IOPTS(8) = 0
    USER INPUT LAND USE HEAT FLUX CONSTANTS (HVOC) IOPTS(9) = 0
    RUN NOT STARTING AT BEGINNING OF SURFACE AND UPPER AIR DATA FILES ? IOPTS(10) = 1

SURFACE WIND SPEED MEASUREMENT HEIGHT (ZW) =  10.0 (M)

VON KARMAN CONSTANT (VK) =  .400

FRICTION VELOCITY CONSTANTS:
    GAMMA =    4.7
    CONSTV = 1100.0

MIXING HEIGHT CONSTANTS:
    NEUTRAL STABILITY MIXING HT CONSTANT (CONSTB) =   1.41
    CONVECTIVE MIXING HT CONSTANT (CONSTE) =    .15
    DEPTH OF LAYER THROUGH WHICH POTENTIAL TEMP. GRADIENT IS CALCULATED (DELTZ) =  200.0 (M)
    MINIMUM STABLE POTENTIAL TEMP. GRADIENT (DPTMIN) =   .0010 (DEG K/M)
    STABLE MECHANICAL MIXING HT CONSTANT (CONSTN) =  2400.0

WIND FIELD VARIABLES:
    SCAN RADIUS (RADIUS) =   99.0 (GRID UNITS)
    CODE FOR LOWER-LEVEL WIND FIELD (ILWF) =  2 (SEE BELOW)
    CODE FOR UPPER-LEVEL WIND FIELD (IUWF) =  4 (SEE BELOW)

         WIND FIELD CODE (ILWF,IUWF)

                    1  -  SURFACE WINDS (CD144 DATA)
                    2  -  WINDS AVERAGED THROUGH LAYER FROM GROUND TO MIXING HT (CD144,TDF5600 DATA)
                    3  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 850 MB (TDF5600 DATA)
                    4  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 700 MB (TDF5600 DATA)
                    5  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 500 MB (TDF5600 DATA)
                    6  -  850 MB WINDS (TDF5600 DATA)
                    7  -  700 MB WINDS (TDF5600 DATA)
                    8  -  500 MB WINDS (TDF5600 DATA)

REDUCTION FACTORS OF SOLAR RADIATION DUE TO CLOUD COVER:
    CLOUD COVER (TENTHS)     0      1      2      3      4      5      6      7      8      9     10
    RETA                 1.000   .910   .840   .790   .750   .720   .680   .620   .530   .410   .250
    TIME PERIOD FOR WHICH INPUT MET. DATA & INTERMEDIATE PARAMETERS PRINTED (NDY1,NHR1,NDY2,NHR2) = DAY   0 HR  0 TO DAY   0 HR  0
    INPUT MET. DATA & INTERMEDIATE COMPUTED PARAMETERS PRINTED ? (LDB) = F
    PRINT FREQUENCY (IPRINF) =   12 (HOURS)
    METEOROLOGICAL FIELDS PRINTED ? (LPRINT) = T
    GENERATED METEOROLOGICAL FIELDS OUTPUT TO TAPE ? (LSAVE) = T

OUTPUT OPTIONS:

    GRID SPACING (DGRID) =    15000.0 (M)
    GRID SIZE IN Y (SOUTH-NORTH) DIRECTION (JMAX) =  30
    GRID SIZE IN X (WEST-EAST) DIRECTION (IMAX) =  28

GRID INFORMATION:

BASE TIME ZONE (IBTZ) =  6 (C.S.T.)
NUMBER OF RAWINSONDE STATIONS (NUSTA) =    2
NUMBER OF SURFACE STATIONS (NSSTA) =    3
NUMBER OF HOURS IN RUN (IHRMAX) = 25
JULIAN DAY OF START OF RUN (IDYSTR) = 235
YEAR OF RUN (IYR) = 78

MESOPAC TEST CASE 25-HOUR RUN -- DAY 235 (AUG. 23, 1978)

**************************************************************************************************************************************************
                                                  MESOPAC   VERSION 1.0   LEVEL 821201
```

APPENDIX C

MESOPAC II TEST CASE INPUTS/OUTPUT

MESOPAC II Test Case

2 Upper Air Stations (Salem, Ill; Nashville, Tenn.)

5 Surface Stations (Memphis, Tenn.; Evansville, Ind.; Nashville, Tenn.)

2 Precipitation Stations (Memphis, Tenn.; Nashville, Tenn.)

MESOPAC II Card-Image Inputs:

```
MESOPAC TEST CASE 25-HOUR RUN -- DAY 235 (AUG. 23, 1978)
  78  235   25    3    2    6
  24   30  15000.
   T    T   12    F    0    0    0    0
 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 4 4 4 4 2 2
 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 4 4 4 2 4 4
 1 1 2 2 2 2 2 2 2 2 2 1 2 2 1 2 2 2 4 4 4 2 2 2
 1 1 2 2 2 2 2 2 2 2 2 1 2 2 1 2 2 2 4 4 4 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 4 4 4 2 2
 2 2 2 2 2 1 2 2 2 2 2 1 2 2 1 2 2 2 2 4 4 4 2 2
 2 2 1 2 2 1 2 2 2 2 2 1 1 1 2 2 2 2 2 4 4 4 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 4 4 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 4 4 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 4 2 2
 2 2 2 4 4 2 2 2 2 4 4 2 2 2 4 2 2 2 4 4 4 4 4 2
 2 2 2 4 4 2 2 2 2 2 2 2 4 4 2 4 4 4 4 4 4 4 4 4
 2 2 2 4 4 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4
 2 2 2 2 2 2 1 1 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2
 2 2 2 2 2 2 1 1 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 4 4 4 2 2 2 4 2 2 2 2 2 2
 1 1 1 2 2 2 2 2 2 2 2 4 4 4 2 2 2 2 4 4 2 2 2 4
 1 1 2 4 4 2 2 2 2 2 2 4 4 4 2 2 2 2 2 2 2 2 2 4
 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 2 2 2 2 2 2 2
 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 2 2 2 2 2 2 2
 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2
 1 1 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2
 2 2 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 4
 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2
 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2
 4 4 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 4
 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 4
 4 4 2 2 2 4 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 2
 2 2 2 2 2 4 4 4 4 4 2 4 4 4 4 4 2 2 2 2 2 2 2 4
 2 2 2 2 4 4 4 4 4 4 2 4 4 4 4 4 2 2 2 2 2 2 2 4
0000000001
13893      1.0       1.4     38.05     90.00    6.   11    405954   21
93817     15.7      23.6     38.05     87.53    6.   12         0  999
13897     21.0       9.3     36.12     86.68    6.   13    406402   23
03879      7.1      28.0     38.65     89.97    6.   31
13897     21.7      10.3     36.25     86.57    6.   32
```

78	8	17	229	12	19
78	8	18	230	0	22
78	8	18	230	12	28
78	8	19	231	0	22
78	8	19	231	12	19
78	8	20	232	0	20
78	8	20	232	12	24
78	8	21	233	0	22
78	8	21	233	12	19
78	8	22	234	0	18
78	8	22	234	12	16
78	8	23	235	0	18
78	8	23	235	12	21
78	8	24	236	0	19
78	8	24	236	12	15
78	8	25	237	0	18
78	8	25	237	12	28
78	8	26	238	0	21
78	8	26	238	12	25
78	8	27	239	0	27
78	8	27	239	12	25
78	8	28	240	0	25
78	8	28	240	12	29
78	8	29	241	0	17
78	8	29	241	12	19
78	8	30	242	0	17
78	8	30	242	12	24
78	8	31	243	0	26

```
READ56   VERSION  1.0   LEVEL 821215
*****************************************************************************************

STARTING DATE:                    ENDING DATE:

          YEAR =  78                        YEAR =  78
          JULIAN DAY = 213                  JULIAN DAY = 243
          HOUR =   0                        HOUR =   0

PRESSURE LEVELS EXTRACTED:

          SURFACE TO   500. MB

DATA LEVEL ELIMINATED IF HEIGHT MISSING ?        T

DATA LEVEL ELIMINATED IF TEMPERATURE MISSING ?   T

DATA LEVEL ELIMINATED IF WIND DIRECTION MISSING ? T

DATA LEVEL ELIMINATED IF WIND SPEED MISSING ?    T

THE FOLLOWING SOUNDINGS HAVE BEEN PROCESSED:

   YEAR    MONTH    DAY    JULIAN DAY    HOUR (GMT)    NO. LEVELS EXTRACTED

    78       8       1        213            0               18
    78       8       1        213           12               24
    78       8       2        214            0               20
    78       8       2        214           12               19
    78       8       3        215            0               16
    78       8       3        215           12               24
    78       8       4        216            0               20
    78       8       4        216           12               22
    78       8       5        217            0               22
    78       8       5        217           12               15
    78       8       6        218            0               19
    78       8       6        218           12               19
    78       8       7        219            0               21
    78       8       7        219           12               25
    78       8       8        220            0               17
    78       8       8        220           12               28
    78       8       9        221            0               33
    78       8       9        221           12               19
    78       8      10        222            0               20
    78       8      10        222           12               24
    78       8      11        223            0               22
    78       8      11        223           12               13
->->->MISSING OR ELIMINATED MANDATORY ( 850.0 MB) PRESSURE LEVEL
    78       8      12        224            0               17
    78       8      12        224           12               21
    78       8      13        225            0               21
    78       8      13        225           12               21
    78       8      14        226            0               25
    78       8      14        226           12               14
    78       8      15        227            0               24
    78       8      15        227           12               23
    78       8      16        228            0               19
    78       8      16        228           12               20
    78       8      17        229            0               22
```

READS6 TEST CASE OUTPUT (RUN #2)

```
78     8     18     230     0      16
78     8     18     230     12     21
78     8     19     231     0      18
78     8     19     231     12     19
78     8     20     232     0      25
78     8     20     232     12     21
78     8     21     233     0      20
78     8     21     233     12     21
78     8     22     234     0      23
78     8     22     234     12     15
->->->MISSING OR ELIMINATED MANDATORY ( 850.0 MB) PRESSURE LEVEL
->->->MISSING OR ELIMINATED MANDATORY ( 700.0 MB) PRESSURE LEVEL
78     8     23     235     0      28
78     8     23     235     12     18
78     8     24     236     0      21
78     8     24     236     12     21
78     8     25     237     0      22
78     8     25     237     12     18
78     8     26     238     0      21
78     8     26     238     12     24
78     8     27     239     0      22
78     8     27     239     12     18
78     8     28     240     0      29
78     8     28     240     12     22
78     8     29     241     0      22
78     8     29     241     12     26
78     8     30     242     0      22
78     8     30     242     12     19
78     8     31     243     0      19
```

```
READ56   VERSION  1.0   LEVEL 821215
**************************************************************************************

STARTING DATE:                      ENDING DATE:

   YEAR = 78                           YEAR = 78
   JULIAN DAY = 213                    JULIAN DAY = 243
   HOUR = 0                            HOUR = 0

PRESSURE LEVELS EXTRACTED:

            SURFACE TO   500. MB

DATA LEVEL ELIMINATED IF HEIGHT MISSING ?          T

DATA LEVEL ELIMINATED IF TEMPERATURE MISSING ?     T

DATA LEVEL ELIMINATED IF WIND DIRECTION MISSING ? T

DATA LEVEL ELIMINATED IF WIND SPEED MISSING ?      T

THE FOLLOWING SOUNDINGS HAVE BEEN PROCESSED:

  YEAR    MONTH    DAY    JULIAN DAY    HOUR (GMT)    NO. LEVELS EXTRACTED

   78       8       1        213            0                 19
   78       8       1        213           12                 31
   78       8       2        214            0                 21
   78       8       2        214           12                 28
   78       8       3        215            0                 21
   78       8       3        215           12                 26
   78       8       4        216            0                 26
   78       8       4        216           12                 36
   78       8       5        217            0                 25
   78       8       5        217           12                 26
   78       8       6        218            0                 27
   78       8       6        218           12                 24
   78       8       7        219            0                 22
   78       8       7        219           12                 29
   78       8       8        220            0                 22
   78       8       8        220           12                 18
   78       8       9        221            0                 19
   78       8       9        221           12                 16
   78       8      10        222            0                 23
   78       8      10        222           12                 25
   78       8      11        223            0                 26
   78       8      11        223           12                 22
   78       8      12        224            0                 21
   78       8      12        224           12                 26
   78       8      13        225            0                 24
   78       8      13        225           12                 20
   78       8      14        226            0                 19
   78       8      14        226           12                 20
   78       8      15        227            0                 17
   78       8      15        227           12                 19
   78       8      16        228            0                 20
   78       8      16        228           12                 29
   78       8      17        229            0                 17
   78       8      17        229           12                 25
```

READS6 TEST CASE OUTPUT (RUN #1)

Table A-2. Flow Diagram for MESOPUFF II

```
*  Read User Inputs, Read Meteorological Data Header Record

*  Write Header Record in Concentration Output File

*  Read Gridded Wind Fields for First Hour

|---  *  Enter Hour Loop
|
|     *  Read Meteorological Data (other than wind data) for
|        Current Hour
|
|     *  Read Gridded Wind Fields for Next Hour
|
|     *  Initialize Concentration Arrays
|
|     |---  *  Enter Puff Loop
|     |
|     |     *  If Puff is New, Initialize Puff, Compute Plume Rise
|     |
|     |     |---  *  Enter Sampling Loop
|     |     |
|     |     |     *  Advect Puff
|     |     |
|     |     |     *  Diffuse Puff (calculate new $\sigma_y$ , $\sigma_z$ -- move
|     |     |        mass in three-layer model)
|     |     |
|     |     |     *  Perform Chemistry Calculations
|     |     |
|     |     |     *  Perform Wet Removal Calculations
|     |     |
|     |     |     *  Perform Dry Deposition Calculations
|     |     |
|     |     |     *  Sample Puff (calculate concentrations at
|     |     |        gridded and nongridded receptors)
|     |     |
|     |     |---  *  End Sampling Loop
|     |
|     |---  End Puff Loop
|
|     *  Compute Average Puff Concentrations (to use in next hour's
|        chemistry calculations)
|
|     *  Compute 'IAVG'-Hour Averaged Concentrations
|
|     *  Write Concentrations to Disk and/or to Printer (if end of
|        averaging period)
|
|     *  Purge Old Puffs Off Computational Grid (if number of puffs
|        approaches limit)
|
|---  End Hour Loop

*  Close Files, Terminate Run
```

```
    |     -     -     -     -
 27 |   275    77    80    84
    |     -     -     -     -
 28 |   275    77    80    83
    |     -     -     -     -
 29 |   276    77   292   301
    |     -     -     -     -
 30 |   278   284    79    81

MULTIPLY ALL VALUES BY 10 **  -1

MONIN-OBUKHOV LENGTH (M)                                      YEAR: 78  MONTH: 8  DAY: 23  JULIAN DAY: 235  HOUR: 11

          1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20
     -----------------------------------------------------------------------------------------------------------------------
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  1 |   124   124   122   118   114   400   377   353   334   322    87   335   450   517   609   725   225   260   292   321
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  2 |   124   124   122   119   115   402   378   354   334   32    87   338   460   536   642   716   243   262   318   349
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  3 |   452   451   120   119   114   400   376   352   332   320   322   416   472   559   682   837   264   307   347   381
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  4 |   119   118   117   114   110   105   100   348   329   319   323   425   487   588   729   906   266   335   319   414
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  5 |   419   418   112   109   105   101    96   335   322   317   326   435   506   620   780   981  1212   365   413   449
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  6 |   346   344   105   103    99    95    91   354   316   318   409   453   532   655   833  1058  1315   365   446   463
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  7 |   373   370    99    97    94    91    88   315   314   323   424   481   573   709   867  1134  1412   422   476   514
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  8 |    95    94   343    91    89    87    85    84   315   405   444   210   613   762   984  1218  1207   405   200   537
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  9 |    86    65    88    87    85    84    83    84    87   113   125   536   646   803  1014  1277  1575  1870  2117  2277
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 10 |    63    63    85    84    83    82    83    85    89   116   129   555   668   825  1037  1300  1568  1860  2130  2277
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 11 |    61    61    82    82    81    82    83    86   110   118   132   563   617   823  1056  1280  1566   426   206   577
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 12 |    60    29    81    81    81    81    83    86   111   116   131   556   655   744   980  1213  1479   432   480   512
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 13 |    29    29    80   256   298    82    83    91    96   118   124   536   620   740   236   266   341   367   444   470
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 14 |    29    28    24    80    91    82    88    91    94   100   107   503   570   666   211   253   302   352  1547  1675
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 15 |    90    80    80    81    86    87    88    89    95    96   101   402   442   506   182   215   256  1171   342   337
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 16 |    90    80    80    86    86    87    64    64    89    91    94    99   344   434   494   574   699   750  1079  1146
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 17 |    90    86    86    86    86    86    63    63    86    86    88    90   348   371   408   494   244   647   724   404
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 18 |    86    96    86   316   316    86    82    82    84    83    82    83   711   422   342   372   429   466   556   611
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 19 |    86    86    96   316   315    85    84    83    82    80    76    77   282   246    81   715   347   746   474   462
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 20 |    47    87    86   316   314    64    63    85    60   288   281    74    73    73   271    76    61    67   334   562
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 21 |    87    87    96    86    85    64    83    91    74    77    72    73    71    70    70    71    73    77    83    61
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 22 |    48    87    67    86    85    84    95    80    78    76    74    72    70    69    69    69    70    72   281   301
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
 23 |    88    88    87    86    85    64    85    80    78    76    73    71    70    69    68    68    69    70   268   262
    |     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
  21 |  1140  1140  1140  1140
     |     +     +     +     +
  20 |  1160  1140  1180  1160
     |     +     +     +     +
  19 |  1140  1140  1140  1140
     |     +     +     +     +
  18 |  1190  1190  1108  1108
     |     +     +     +     +
  17 |  1108  1108  1108  1108
     |     +     +     +     +
  16 |  1108  1108  1108  1108
     |     +     +     +     +
  15 |  1108  1108  1108  1108
     |     +     +     +     +
  14 |  1108  1108  1108  1108
     |     +     +     +     +
  13 |  1108  1108  1108  1108
     |     +     +     +     +
  12 |  1108  1108  1108  1108
     |     +     +     +     +
  11 |  1108  1108  1108  1108
     |     +     +     +     +
  10 |  1108  1108  1108  1108
     |     +     +     +     +
   9 |  1108  1108  1108  1108
     |     +     +     +     +
   8 |  1108  1108  1108  1108
     |     +     +     +     +
   7 |  1108  1108  1108  1108
     |     +     +     +     +
   6 |  1108  1108  1108  1108
     |     +     +     +     +
   5 |  1108  1108  1108  1108
     |     +     +     +     +
   4 |  1108  1108  1108  1108
     |     +     +     +     +
   3 |  1108  1108  1108  1108
     |     +     +     +     +
   2 |  1108  1108  1108  1108
     |     +     +     +     +
   1 |  1108  1108  1108  1108
     |     +     +     +     +
      ------------------------
        21    22    23    24

MONIN-OBUKHOV LENGTH (M)                          YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11
MULTIPLY ALL VALUES BY 10 **  -1

30 |  94   93   93   95   91   90   88   87   82   83   01   29   78   77   75   75   74   74  274  275
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
29 |  93   95   95   91   90   84   87   45   83   29   28   27   76   75   74   73   73   73  269  271
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
28 |  67   67   91   90   89   87   86   44   85   80   78   26   74   73   23   71   71   71  264  268
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
27 |  67   66   90   49   86   46   44   43   81   74   76   24   73   75   21   70   70   70  262  267
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
26 |  90   90   49   48   47   42   43   42   79   77   75   73   52   21   21   69   69   70   71  267
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
25 |  90   49   48   47   46   62   83   61   79   76   74   23   71   69   50   64   69   69   71  269
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
24 |  89   44   64   47   85   61   82   40   78   76   73   52   51   50   64   68   66   69   71  273
```

C18

```
     |   +     +     +     +
  22 | 1180  1180  1180  1180
     |   +     +     +     +
  23 | 1180  1180  1180  1180
     |   +     +     +     +
  24 | 1180  1180  1180  1180
     |   +     +     +     +
  25 |  819  1180  1180  1180
     |   +     +     +     +
  26 |  819   819  1180  1180
     |   +     +     +     +
  27 |  819   819   819  1180
     |   +     +     +     +
  28 |  819   819   819   819
     |   +     +     +     +
  29 |  819   819   819   819
     |   +     +     +     +
  30 |  819   819   819   819

MULTIPLY ALL VALUES BY 10 **   0

MIXING HEIGHT (M)                                         YEAR: 78  MONTH:  8  DAY: 25  JULIAN DAY: 235  HOUR: 11

        1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

      -------------------------------------------------------------------------------------------------------------------
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   1 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   2 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   3 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   4 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   5 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   6 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   7 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   8 | 1198  1198  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   9 |  873   873  1198  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  10 |  873   873   873  1198  1198  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  11 |  873   873   873   873  1198  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  12 |  873   873   873   873   873  1198  1198  1198  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  13 |  873   873   873   873   873   873  1198  1180  1180  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  14 |  873   873   873   873   873   873   819   819  1180  1180  1180  1108  1108  1108  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  15 |  873   873   873   873   819   819   819   819   819  1180  1180  1180  1180  1180  1108  1108  1108  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  16 |  873   873   873   819   819   819   819   819   819   819  1180  1180  1180  1180  1180  1180  1180  1108  1108  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  17 |  873*  819   819   819   819   819   819   819   819   819   819  1180  1180  1180  1180  1180  1180  1180  1180  1108
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  18 |  819   819   819   819   819   819   819   819   819   819   819   819   819  1180  1180  1180  1180  1180  1180  1180
     |   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
```

```
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
13 |  193  193  193  193  193  193  193  177  177  148  148  148  149  148  148  149  149  148  149  149  148  146  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
12 |  193  193  193  193  193  193  193  193  148  146  148  148  149  148  148  148  148  144  149  148  148  148  149  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
11 |  193  193  193  193  193  193  193  193  149  148  148  149  145  148  144  149  148  144  148  146  148  143  149  149
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
10 |  193  193  193  193  193  193  193  193  193  148  148  148  146  148  148  148  148  148  148  149  149  149  149  149
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 9 |  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  148  148  149  146  148  148  149  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 8 |  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  149  148  148  146  148  149  149  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 7 |  193  193  193  193  193  193  193  193  193  193  148  148  148  148  144  144  148  144  148  146  148  143  144  149
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 6 |  193  193  193  193  193  193  193  193  193  193  148  148  149  148  148  148  149  149  148  148  148  146  146  149
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 5 |  193  193  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  148  149  149  148  149  149  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 4 |  193  193  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  148  148  148  149  149  148  146
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 3 |  193  193  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  148  148  148  148  148  148  146
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 2 |  193  193  193  193  193  193  193  193  193  193  193  193  148  148  148  148  149  148  148  148  148  148  149  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 1 |  193  193  193  193  193  193  193  193  193  193  193  193  148  148  148  148  148  148  148  148  148  148  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
    --------------------------------------------------------------------------------------------------------------------------
        1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

SURFACE FRICTION VELOCITY (M/S)                                          YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11

MULTIPLY ALL VALUES BY 10 **  -3
30 |  278  278  277  276  275  274  272  271  269  267  265  237  262  260  259  258  257  257  397  398  399  402  263  265
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 |  277  277  276  272  274  273  271  269  267  279  237  235  260  258  257  256  255  255  395  396  399  260  406  410
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 |  269  268  275  274  273  271  270  268  266  264  261  234  257  256  259  254  254  254  393  395  348  260  263  261
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 |  268  268  274  273  272  270  269  267  264  265  260  232  256  254  258  255  255  253  391  364  348  261  264  268
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 |  275  274  273  272  271  269  268  265  263  261  258  256  229  227  227  251  251  255  253  394  399  404  266  270
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 |  274  273  273  271  270  265  267  265  265  260  257  229  253  255  226  250  251  251  253  395  401  407  269  273
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 |  273  273  265  271  270  261  266  264  265  259  256  229  227  226  250  250  250  252  254  397  464  412  273  278
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 |  273  275  271  270  269  268  266  264  261  259  256  254  255  251  250  250  251  255  395  405  411  450  279  265
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 |  275  275  271  270  269  268  266  264  265  259  257  254  255  251  251  251  255  255  401  410  451  433  267  263
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 |  271  271  271  270  269  268  267  265  263  260  258  255  254  253  253  253  256  261  267  275  438  451  294  365
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
20 |  271  271  271  417  416  269  267  266  264  404  401  257  256  256  396  259  264  271  433  448  463  476  486  314
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
19 |  271  270  270  417  417  269  268  267  266  264  265  261  403  405  265  416  430  447  463  480  494  566  514  519
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
18 |  270  270  270  417  417  270  269  269  268  267  268  267  415  450  458  445  461  485  503  519  532  541  549  592
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
17 |  271  279  270  270  270  270  264  264  270  270  272  275  470  440  454  474  500  574  550  558  568  766  767  766
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
7 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
6 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
5 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
4 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
3 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
2 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
1 |  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2
 |  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
   --------------------------------------------------------------------------

     1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

METEOROLOGICAL DATA AT SURFACE STATIONS - YR:78  JULIAN DAY:235  HR:11
 STATION   PRES.     TEMP    SOLAR RAD.   REL. HUMIDITY   CLOUD COVER   PRECIP. CODE

    1      .000     302.4     824.5          47              0            0
    2      .000     303.1     757.5          54              1            0
    3      .000     303.1     610.6          65              2            0

SURFACE KINEMATIC HEAT FLUX (M*DEG K/S)                     YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11

MULTIPLY ALL VALUES BY 10 **  -3

30 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
20 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
19 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
18 |  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
17 |  193  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  177  148  149  148  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
16 |  193  193  193  177  177  177  177  177  177  177  177  177  177  177  177  177  177  148  148  148  148  148  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
15 |  193  193  193  193  177  177  177  177  177  177  177  177  177  177  148  149  148  148  148  148  148  148  148  148
   |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
14 |  193  193  193  193  193  193  177  177  177  177  177  148  149  148  148  148  148  148  148  148  148  148  148  148
```

```
 5 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 4 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 3 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 2 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 1 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
    ------------------------------------------------------------------------
      1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

PCT STABILITY CLASS                                    YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11

MULTIPLY ALL VALUES BY 10 **    0

30 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
29 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
28 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
27 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
26 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
25 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
24 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
23 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
22 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
```

```
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 2 I  1  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 1 I  1  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
     ------------------------------------------------------------------------
      1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

STATION NUMBER OF CLOSEST RAWINSONDE STATION TO EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **    0

30 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
29 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
28 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
27 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
26 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
25 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
24 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
23 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
22 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I  1  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I  1  1  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I  1  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I  1  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I  1  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I  1  1  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I  1  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I  1  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I  1  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 7 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 6 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
                    MESOPAC   VERSION 1.0   LEVEL 821201
*****************************************************************************************************************

STATION NUMBER OF CLOSEST SURFACE MET. STATION TO EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **   0

30 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
29 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
28 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
27 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
26 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
25 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
24 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
23 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
22 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I  1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I  1  1  1  1  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I  1  1  1  1  1  1  2  2  2  2  2  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I  1  1  1  1  1  1  1  2  2  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 7 I  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 6 I  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 5 I  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 4 I  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 3 I  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
```

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                                        MESOPAC   VERSION 1.0   LEVEL 821201
*****************************************************************************************************************************

SURFACE METEOROLOGICAL STATIONS

STATION   CD144 ID      GRID COORDINATES         LATITUDE    LONGITUDE    TIME ZONE    CD144      TD9657 ID    TD9657
                          X            Y         (DEGREES)   (DEGREES)                 LOGICAL                 LOGICAL
                      (GRID UNITS)  (GRID UNITS)                                       UNIT                    UNIT

   1       13893        1.00         1.40         38.050      90.000         6.         11        405954         21
   2       93817       15.70        23.60         38.050      87.530         6.         12        0             999
   3       13897       21.00         9.30         36.120      86.680         6.         13        406402         23

RAWINSONDE METEOROLOGICAL STATIONS

STATION   TDF5600 ID    GRID COORDINATES         LATITUDE    LONGITUDE    TIME ZONE    TDF5600
                          X            Y         (DEGREES)   (DEGREES)                 LOGICAL
                      (GRID UNITS)  (GRID UNITS)                                       UNIT

   1       3879         7.10        28.00         38.650      89.970         6.         31
   2       13897       21.70        10.30         36.250      86.570         6.         32
   I    +     +     +     +
12 I  2000  2000  2000  2000
   I    +     +     +     +
11 I  2000  2000  2000  2000
   I    +     +     +     +
10 I  2000  2000  2000  2000
   I    +     +     +     +
 9 I  2000  2000  2000  2000
   I    +     +     +     +
 8 I  2000  2000  2000  2000
   I    +     +     +     +
 7 I  2000  2000  2000  2000
   I    +     +     +     +
 6 I  2000  2000  2000  2000
   I    +     +     +     +
 5 I  2000  2000  2000  2000
   I    +     +     +     +
 4 I  2000  2000  2000  2000
   I    +     +     +     +
 3 I  2000  2000  2000  2000
   I    +     +     +     +
 2 I  2000  2000  2000  2000
   I    +     +     +     +
 1 I  2000  2000  2000  2000
   I    +     +     +     +
    ------------------------
      21    22    23    24
```

```
11 | 3000   3000   3000   3000
   |    +      +      +      +
12 | 3000   3000   3000   3000
   |    +      +      +      +
13 | 3000   3000   3000   3000
   |    +      +      +      +
14 | 3000   3000   3000   3000
   |    +      +      +      +
15 | 3000   3000   3000   3000
   |    +      +      +      +
16 | 3000   3000   3000   3000
   |    +      +      +      +
17 | 3000   3000   3000   3000
   |    +      +      +      +
18 | 3000   3000   3000   3000
   |    +      +      +      +
19 | 3000   3000   3000   3000
   |    +      +      +      +
20 | 3000   3000   3000   3000
   |    +      +      +      +
21 | 3000   3000   3000   3000
   |    +      +      +      +
22 | 3000   3000   3000   3000
   |    +      +      +      +
23 | 3000   3000   3000   3000
   |    +      +      +      +
24 | 3000   3000   3000   3000
   |    +      +      +      +
25 | 3000   3000   3000   3000
   |    +      +      +      +
26 | 3000   3000   3000   3000
   |    +      +      +      +
27 | 3000   3000   3000   3000
   |    +      +      +      +
28 | 3000   3000   3000   3000
   |    +      +      +      +
29 | 3000   3000   3000   3000
   |    +      +      +      +
30 | 3000   3000   3000   3000

MULTIPLY ALL VALUES BY 10 **  -4

LAND USE HEAT FLUX CONSTANTS (HADC) AT EACH GRID POINT

       1      2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     18     19     20

   ------------------------------------------------------------------------------------------------------------------------------------------
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 1 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 2 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 3 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 4 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 5 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 6 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 7 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 8 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 9 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
   |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
10 | 3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
```

```
    |    +      +      +      +
  7 |  3000   3000   3000   3000
    |    +      +      +      +
  6 |  3000   3000   3000   3000
    |    +      +      +      +
  5 |  3000   3000   3000   4000
    |    +      +      +      +
  4 |  3000   3000   3000   4000
    |    +      +      +      +
  3 |  3000   3000   3000   3000
    |    +      +      +      +
  2 |  3000   3000   3000   4000
    |    +      +      +      +
  1 |  3000   3000   3000   4000
    |    +      +      +      +
     -------------------------

      21     22     23     24

LAND USE HEAT FLUX CONSTANTS (KADC) AT EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **  -6

 30 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 29 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 28 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 27 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 26 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 25 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 24 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 23 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 22 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 21 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 20 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 19 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 18 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 17 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 16 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 15 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 14 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 13 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 12 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
 11 |  3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000   3000
    |    +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
  8 | 3000  3000  3000  9000
    |    +     +     +     +
  9 | 3000  3000  3000  3000
    |    +     +     +     +
 10 | 3000  3000  3000  3000
    |    +     +     +     +
 11 | 3000  3000  3000  3000
    |    +     +     +     +
 12 | 3000  3000  3000  3000
    |    +     +     +     +
 13 | 3000  3000  3000  9000
    |    +     +     +     +
 14 | 3000  3000  3000  9000
    |    +     +     +     +
 15 | 3000  3000  3000  3000
    |    +     +     +     +
 16 | 9000  3000  3000  3000
    |    +     +     +     +
 17 | 9000  3000  3000  3000
    |    +     +     +     +
 18 | 9000  9000  9000  9000
    |    +     +     +     +
 19 | 9000  9000  9000  9000
    |    +     +     +     +
 20 | 9000  9000  9000  3000
    |    +     +     +     +
 21 | 9000  9000  3000  3000
    |    +     +     +     +
 22 | 9000  9000  3000  3000
    |    +     +     +     +
 23 | 9000  9000  3000  3000
    |    +     +     +     +
 24 | 9000  9000  3000  3000
    |    +     +     +     +
 25 | 9000  9000  3000  3000
    |    +     +     +     +
 26 | 9000  9000  3000  3000
    |    +     +     +     +
 27 | 9000  3000  3000  3000
    |    +     +     +     +
 28 | 9000  3000  3000  3000
    |    +     +     +     +
 29 | 9000  3000  9000  9000
    |    +     +     +     +
 30 | 9000  9000  3000  3000

MULTIPLY ALL VALUES BY 10 **  -4

SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

       1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

   -----------------------------------------------------------------------------------------------------------------------
    |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  1 | 3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  3000  9000  9000  9000  9000  9000  3000  3000  3000  3000
    |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  2 | 3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  3000  9000  9000  9000  9000  9000  3000  3000  3000  3000
    |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  3 | 9000  9000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000  3000
    |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  4 | 3000  3000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000  3000
    |    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  5 | 9000  9000  3000  3000  3000  3000  3000  9000  9000  9000  9000  9000  9000  9000  9000  9000  9000  3000  3000  3000
```

```
28 |   27    17    21    26
   |    +     +     +     +
27 |   24    16    21    27
   |    +     +     +     +
26 |   23    34    22    28
   |    +     +     +     +
25 |   23    36    24    31.
   |    +     +     +     +
24 |   29    41    27    35
   |    +     +     +     +
23 |   32    50    33    41
   |    +     +     +     +
22 |   46    66    41    51
   |    +     +     +     +
21 |   69    92    54    64
   |    +     +     +     +
20 |  106   131   123    81
   |    +     +     +     +
19 |  161   145   598   393
   |    +     +     +     +
18 |  464   522   611   644
   |    +     +     +     +
17 |  845   297   308   305
   |    +     +     +     +
16 | 1224   476   467   445
   |    +     +     +     +
15 |  645   630   611   573
   |    +     +     +     +
14 |  793   772   738  1666
   |    +     +     +     +
13 |  911   488   843  1865
   |    +     +     +     +
12 |  975   971   923   827
   |    +     +     +     +
11 | 1049  1027   976   910
   |    +     +     +     +
10 | 1076  1057  1010   944
   |    +     +     +     +
 9 | 1080  1065  1022   961
   |    +     +     +     +
 8 | 1066  1054  1017  2242
   |    +     +     +     +
 7 | 1037  1030   998   920
   |    +     +     +     +
 6 |  976   996   969   927
   |    +     +     +     +
 5 |  948   926   932  2101
   |    +     +     +     +
 4 |  843   911   840  2025
   |    +     +     +     +
 3 |  832   829   842   819
   |    +     +     +     +
 2 |  774   803   798  1823
   |    +     +     +     +
 1 |  714   746   721  1762
   |    +     +     +     +
    -------------------------
      21    22    23    24

CONVECTIVE VELOCITY SCALE (M/S)                YEAR: 74  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

GRID NOT PRINTED -- ALL VALUES ZERO
```

```
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  25 I    20    20    19    17    16    11    12    10     7     5     3     1     1     0     0     0     0     1     3    13
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  24 I    20    20    15    14    16    12    12    10     8     5     3     1     0     0     0     0     0     1     3    14
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  23 I    20    20    19    14    17    15    13    11     8     6     4     2     1     0     0     0     0     1     8    18
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  22 I    20    20    20    19    19    16    15    12    10     7     5     3     1     1     0     0     1     2    14    27
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  21 I    21    21    20    20    19    18    16    14    12    10     7     5     3     2     1     2     3     6    13    22
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  20 I    21    21    21    44    44    20    19    17    15    28    24     9     7     6    12     6     4    16    56    80
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  19 I    20    21    22    46    47    22    22    21    20    18    17    15    30    29    15    37    50    72   105   135
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  18 I    20    21    22    48    50    24    25    25    25    25    24    24    53    56    64    78   100   133   175   338
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  17 I    19    21    22    23    25    26    22    23    31    32    34    36    84    94   111   135   167   321   592   796
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  16 I    18    20    22    24    26    28    25    27    36    40    44    49   120   140   168   700   579   769   945  1117
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  15 I    17    19    21    23    26    29    33    37    45    48    55   134   129   189   107   130   596  1140   541   633
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  14 I    12    14    16    22    25    29    34    40    47    55    64   162   195   496   149   324   461   297  1691  1991
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  13 I    11    12    17    43    51    29    34    41    50    40    72   186   457   655   303   447   588   717   622   895
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  12 I     9    10    15    18    22    27    33    41    51    63    78   303   547   794  1096  1360  1626   811   912   977
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  11 I     7     9    12    15    19    24    31    40    51    65    82   376   659   890  1178  1484  1795   873   911  1031
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  10 I     5     6    10    12    16    21    28    37    49    64    83   407   669   966  1244  1224  1925  2116  2521  2442
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   9 I     4     4     7     9    13    18    24    34    46    62    81   406   681   967  1270  1279  1975  2132  2528  2448
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   8 I     3     3    10     6     9    14    20    30    89   123   166   380   666   958  1262  1568  1927   986   988  1044
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   7 I     3     4     3     4     7    10    16    23    39   113   156   329   630   924  1227  1527  1807   469   957  1012
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   6 I     2     2     2     3     4     8    13    44    69   102   145   538   577   871  1164  1461  1731   828   912   967
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   5 I     1     1     1     1     3     5    10    37    59    91   133   184   511   403  1094  1376  1034   777   858   915
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   4 I     0     0     0     1     2     4     8    30    51    81   121   170   435   752  1006  1276   616   716   799   856
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   3 I     0     0     0     0     1     6    13    26    45    73   111   157   349   641   911  1168   558   657   736   794
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   2 I     0     0     0     0     1     5    11    23    40    66    48   145   233   556   812  1029   498   564   672   731
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   1 I     0     0     0     0     1     5    10    21    38    62    44   135   183   473   721   952   439   532   604   649
     I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
       ------------------------------------------------------------------------------------------------------------------------
           1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

[illegible] LENGTH (M)                                     YEAR: 79  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -1

  30 I    34    41    23    27
     I     +     +     +     +
  29 I    30    18    47    56
     I     +     +     +     +
```

178

YEARS: 78 MONTHS: 9 DAY: 23 JULIAN DAY: 255 HOUR: 23

MIXING HEIGHT (M)

MULTIPLY ALL VALUES BY 10 ** -1

```
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 15 |  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 14 |  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 13 |  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 12 |  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 11 |  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
 10 |  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  9 |  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  8 |  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  7 |  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  6 |  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  5 |  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  4 |  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  3 |  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  2 |  217  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
  1 |  217  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220  220  220  220  220  220
    |    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
     --------------------------------------------------------------------------------------------------------------------------

         1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

SURFACE FRICTION VELOCITY (M/S)                                         YEAR: 78  MONTH: 8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -3

 30 |   45   44   43   41   40   38   37   35   33   30   28   24   25   25   25   25   57   29   46   51   56   61   46   50
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 29 |   44   43   45   41   39   37   35   33   30   25   23   21   21   20   20   21   22   25   41   46   52   40   65   71
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 28 |   39   38   42   40   34   34   34   31   29   26   23   18   16   16   14   16   19   21   32   42   49   39   44   49
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 27 |   39   34   41   40   34   36   33   30   27   24   20   15   14   12    9   11   13   16   30   38   47   38   44   49
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 26 |   43   42   41   40   38   35   33   30   26   22   18   14   10    7    5    6    8   12   18   32   45   55   45   51
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 25 |   43   42   41   40   38   32   33   30   26   22   17   11    8    5    2    2    5    9   16   34   46   57   46   53
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 24 |   43   42   37   40   34   32   33   30   26   22   17   11    7    3    1    0    3    9   16   35   49   61   49   56
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 23 |   43   43   42   41   36   37   35   31   28   23   18   13    8    4    1    1    3    9   26   40   54   67   54   61
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 22 |   43   43   42   41   44   39   36   33   30   26   21   16   11    7    5    4    8   14   35   50   64   74   61   66
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 21 |   43   43   43   43   42   40   39   36   33   30   26   21   17   14   12   12   16   24   35   45   77   92   76   76
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 20 |   43   44   44   63   63   42   41   40   34   51   46   29   25   23   33   24   59   38   75   60   96  109  116   66
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 19 |   43   44   40   65   65   45   40   49   42   41   39   37   52   51   36   24   67   41   97  111  121  130  142  147
    |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
9 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
8 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
7 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
6 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
5 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
4 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
3 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
2 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
1 | 6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
  | +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
   -----------------------------------------------------------------------

    1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

METEOROLOGICAL DATA AT SURFACE STATIONS - YR:79  JULIAN DAY:237  HR:23
 STATION   PREC.      TEMP.    SOLAR RAD.   REL. HUMIDITY   CLOUD COVER   PRECIP. CODE
    1      .000       297.6        .0            74              0              0
    2      .000       296.5        .0            78              0              0
    3      .000       298.1        .0            85              0              0

SURFACE KINEMATIC HEAT FLUX (M*DEG K/S)                     YEAR: 79  MONTH:  8  DAY: 25  JULIAN DAY: 237  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -4

30 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
29 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
28 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
27 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
26 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
25 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
24 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
23 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
22 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
21 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
20 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
19 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
18 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  220  220
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
17 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220
   |   -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -    -
16 | 217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  217  220  220  220  220  220  220  220
```

```
  7 I  258  259  260  261  262  264  265  267  268  270  272  273  275  276  278  279  280  280  281  281  281  282  281  281
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  6 I  259  260  261  262  263  264  266  267  269  271  272  274  275  277  278  279  280  280  281  281  281  281  281  281
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  5 I  259  260  261  263  264  265  267  268  270  271  273  274  275  277  278  279  279  280  280  281  281  281  281  281
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  4 I  260  261  262  263  265  266  267  269  270  271  273  274  275  276  278  278  279  280  280  281  281  281  281  281
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  3 I  261  262  263  264  265  266  268  269  270  272  273  274  275  276  277  278  279  279  280  280  280  280  280  280
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  2 I  261  262  263  265  266  267  268  269  271  272  273  274  275  276  277  278  279  279  280  280  280  280  280  280
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  1 I  262  263  264  265  266  267  268  270  271  272  273  274  275  276  277  278  278  274  279  280  280  280  280  280
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
      ------------------------------------------------------------------------------------------------------------------------
         1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

PGT STABILITY CLASS                                        YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **   0
 30 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 29 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 28 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 27 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 26 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 25 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 24 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 23 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 22 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 21 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 20 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 19 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 18 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 17 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 16 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 15 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 14 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 13 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 12 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 11 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
    I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 10 I  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
```

```
MULTIPLY ALL VALUES BY 10 **  -2
30 I   41   41   41   41   42   43   44   45   47   49   51   53   55   57   60   61   62   62   62   61   60   57   53   50
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 I   42   42   42   43   43   44   45   47   49   51   53   56   58   61   63   65   65   65   64   63   60   57   53   49
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 I   44   44   44   44   45   46   47   49   51   53   56   59   62   64   67   68   69   68   67   64   63   56   52   48
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 I   45   45   45   45   46   47   49   50   53   55   59   62   65   68   70   72   75   71   69   62   61   56   51  349
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 I   47   46   46   47   47   48   50   52   55   58   61   62   68   72   74   75   75   74   70   62   60   54  348  351
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 I   48   48   48   48   49   50   51   53   56   59   63   67   71   74   77   78   78   74   70   64   58  346  350  353
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 I   50   49   49   49   50   51   52   54   57   60   64   68   73   76   79   80   78   74   68   61  344  348  352  356
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 I   51   51   50   50   50   51   53   55   57   61   62   69   73   77   79   79   77   71   64  343  347  352  356  359
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 I   53   52   51   51   51   52   53   55   57   60   64   68   72   75   77   76   72  339  342  347  352  356  360  363
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 I   55   54   53   52   52   52   53   54   56   59   62   66   69   71   71   69  339  343  348  353  358  362  366  368
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
20 I   57   56   54   53   53   52   52   53   55   57   59   62   64   64   62  342  346  351  356  361  362  369  372  374
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
19 I   59   58   56   55   53   52   52   52   53   54   55   57   56   54  346  350  355  360  365  370  373  377  379  380
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
18 I   62   60   58   56   54   53   52   51   50   50   51   49   46  352  355  359  362  371  372  379  382  385  386  387
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
17 I   66   63   61   58   56   54   52   50   48   47   44  355  357  360  363  369  372  381  386  389  391  392  393  393
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
16 I   70   67   64   61   58   55   52   49   46   42  359  361  364  367  372  378  384  391  396  398  399  400  400  399
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
15 I   74   72   68   65   61   57   53   49   44  362  364  366  370  374  380  386  393  399  404  406  407  407  406  404
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
14 I   80   77   73   70   65   61   56   50  364  366  368  372  376  381  387  393  400  406  410  412  413  412  411  409
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
13 I   86   83   80   75   71   65  364  365  367  369  372  376  380  386  392  399  402  411  412  417  417  417  412  413
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
12 I   94   91   87   82   77  362  366  368  370  372  375  379  384  390  396  403  409  414  418  421  421  420  418  416
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
11 I  102   99   95   90  366  367  368  370  372  374  377  381  386  392  399  405  411  417  421  423  423  422  420  418
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
10 I  110  108  104  367  367  368  369  371  373  375  379  383  388  394  400  406  413  418  421  424  424  424  422  419
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 9 I  120  117  367  367  368  369  370  372  374  376  380  384  389  394  400  407  413  418  421  424  424  424  422  420
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 8 I  367  367  368  368  369  369  370  372  374  376  380  384  389  394  400  406  412  417  420  423  424  424  422  420
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 7 I  368  368  368  368  369  369  371  372  374  376  380  383  388  393  399  402  410  412  419  421  423  423  422  420
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 6 I  368  368  368  368  369  369  370  372  374  376  379  383  387  392  398  403  409  413  417  420  421  421  421  419
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 5 I  364  364  368  368  369  369  370  371  373  375  378  382  386  391  397  402  407  411  415  417  419  420  419  418
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 4 I  364  368  368  368  368  369  370  371  373  375  378  382  386  390  395  400  402  409  413  415  417  418  418  417
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 3 I  368  368  368  368  368  369  370  371  373  375  378  381  382  389  394  399  403  407  410  413  414  415  416  416
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 2 I  368  368  368  368  368  369  370  371  373  375  378  381  382  389  393  397  401  402  408  410  412  413  414  414
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 1 I  368  368  368  368  368  369  370  371  373  375  377  381  384  388  392  396  399  403  406  408  410  411  412  413
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
      -----------------------------------------------------------------------------------------------------------------------
```

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LOWER LEVEL WIND U-FIELD (M/S)                                            YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11

         1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

      -----------------------------------------------------------------------------------------------------------------------
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   1  |  195  195  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   2  |  195  195  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   3  |  195  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   4  |  195  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   5  |  195  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   6  |  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   7  |  195  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   8  |  195  195  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   9  |  176  176  195  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  10  |  176  176  176  195  195  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  11  |  176  176  176  176  195  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  12  |  176  176  176  176  176  195  195  195  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  13  |  176  176  176  176  176  176  195  189  189  175  175  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  14  |  176  176  176  176  176  176  167  167  189  189  189  175  175  175  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  15  |  176  176  176  176  167  167  167  167  167  189  189  189  189  189  175  175  175  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  16  |  176  176  176  167  167  167  167  167  167  167  189  189  189  189  189  189  189  175  175  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  17  |  176  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189  189  175  175  175  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  18  |  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189  189  189  175  175
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  19  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  20  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  21  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  22  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  23  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  24  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  25  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  26  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  27  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  189
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  28  |  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167
      |    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 |  216   248    82    86
   |   -     -     -     -
25 |  240   294    44    49
   |   -     -     -     -
24 |  248   305    88    94
   |   -     -     -     -
23 |  302   324    94   101
   |   -     -     -     -
22 |  326   354   103   110
   |   -     -     -     -
21 |  367   400   117   125
   |   -     -     -     -
20 |  452   469   500   141
   |   -     -     -     -
19 |  527   565   595   611
   |   -     -     -     -
18 |  657   691   821   829
   |   -     -     -     -
17 |  953   256   257   254
   |   -     -     -     -
16 | 1184   306   302   294
   |   -     -     -     -
15 |  563   360   350   335
   |   -     -     -     -
14 |  420   412   396  1490
   |   -     -     -     -
13 |  471   460   440  1655
   |   -     -     -     -
12 |  513   501   476   445
   |   -     -     -     -
11 |  545   530   504   470
   |   -     -     -     -
10 |  559   548   522   488
   |   -     -     -     -
 9 |  562   554   530   498
   |   -     -     -     -
 8 |  552   548   528  2047
   |   -     -     -     -
 7 |  552   534   517   495
   |   -     -     -     -
 6 |  504   512   501   480
   |   -     -     -     -
 5 |  472   484   481  1883
   |   -     -     -     -
 4 |  459   453   458  1798
   |   -     -     -     -
 3 |  405   422   431   425
   |   -     -     -     -
 2 |  374   391   403  1619
   |   -     -     -     -
 1 |  345   363   376  1530
   |   -     -     -     -
    -------------------------

     21    22    23    24

CONVECTIVE VELOCITY SCALE (M/S)                    YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 11

MULTIPLY ALL VALUES BY 10 ** -2

30 | 167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167
   |  +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 | 167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167  167
```

```
LOWER LEVEL WIND U-FIELD (M/S)                                                  YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -2

30 I     8     8     8     8     8     7     7     6     6     6     5     5     5     5     5     5     5     6     6     7     7     8     9     9
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
29 I     8     8     8     8     7     7     7     6     6     5     5     4     4     4     4     4     4     5     5     6     7     8     8     9
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
28 I     8     8     8     8     7     7     6     6     5     5     4     4     3     3     3     3     3     4     5     5     6     7     8     9
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -
27 I     8     8     8     7     7     7     6     6     5     4     4     3     3     2     2     2     2     3     4     5     6     7     8   177
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +
26 I     8     8     8     7     7     7     6     6     5     4     3     3     2     1     1     1     2     2     3     5     6     7   160   182
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +
25 I     8     8     8     7     7     7     6     6     5     4     3     2     2     1     1     0     1     2     3     4     6   140   166   190
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +
24 I     8     8     8     8     7     7     6     6     5     4     3     2     1     1     0     0     0     1     3     5   119   150   178   202
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +
23 I     8     8     8     8     7     7     6     6     5     4     3     3     2     1     0     0     1     2     3    99   134   166   195   220
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +
22 I     8     8     8     8     8     7     7     6     6     5     4     3     2     1     1     1     1    51    87   123   159   192   220   244
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +
21 I     8     8     8     8     8     8     7     7     6     6     5     4     3     3     2     2    58    85   124   160   195   226   252   273
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +
20 I     8     8     8     8     8     8     8     7     7     7     6     5     5     4     4    87   105   136   176   211   242   269   291   308
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +
19 I     8     8     8     8     8     8     8     8     8     8     7     7     7     7   131   143   166   200   241   273   299   320   336   347
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +
18 I     8     8     8     9     9     9     9     9     9     9     9     9     9   177   188   207   236   271   311   341   360   374   384   389
   I     -     -     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +
17 I     8     8     8     9     9     9     9    10    10    10    10   206   215   229   248   274   306   343   380   409   421   428   431   431
   I     -     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +
16 I     8     8     8     9     9     9    10    10    11    11   228   241   257   278   305   336   372   409   444   470   477   479   476   470
   I     -     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +
15 I     7     8     8     9     9    10    10    11    12   237   253   273   296   323   355   391   429   465   497   522   525   523   516   506
   I     -     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
14 I     7     7     8     8     9    10    10    11   234   253   275   300   328   361   397   436   475   510   539   561   564   559   550   536
   I     -     -     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
13 I     7     7     7     8     9    10   201   220   242   265   292   321   354   391   430   471   510   544   571   589   593   587   576   561
   I     -     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
12 I     6     6     7     8     8   178   198   221   245   273   303   337   373   413   454   496   535   568   593   609   613   607   596   580
   I     -     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
11 I     5     6     6     7   150   169   192   217   245   276   310   346   386   428   471   513   551   584   607   621   626   621   609   593
   I     -     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
10 I     5     5     6   120   137   158   182   210   240   274   311   351   393   436   480   522   560   591   614   628   632   627   617   601
   I     -     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 9 I     4     4    90   104   122   143   169   199   232   269   309   351   395   440   484   525   562   593   615   628   633   629   619   605
   I     -     -     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 8 I    57    64    73    87   105   124   155   186   222   261   303   347   393   438   483   524   560   590   611   625   624   627   618   605
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 7 I    43    48    57    70    88   111   139   172   209   250   294   340   387   433   478   518   554   583   604   617   623   621   614   602
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 6 I    30    34    42    54    72    95   123   157   195   237   283   330   378   425   469   510   545   573   593   607   613   613   607   597
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 5 I    19    22    29    41    57    80   108   142   181   225   271   319   367   414   458   498   532   560   580   594   602   604   598   589
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 4 I    10    12    19    29    45    67    95   129   169   212   259   307   355   402   445   484   518   545   565   580   589   593   588   580
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 3 I     4     6    11    21    37    58    86   119   158   201   247   295   343   389   431   469   502   529   549   564   574   580   577   570
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
 2 I     1     2     7    17    32    53    79   112   150   192   237   284   330   375   416   453   485   512   532   548   559   566   565   560
   I     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
```

C34

```
 1 I    0    2    7   16   31   50   76  108  144  185  228  273  318  361  401  437  468  495  515  532  544  552  553  546
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
    ----------------------------------------------------------------------------------------------------------------------

        1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

LOWER LEVEL WIND V-FIELD (M/S)                                        YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -2

30 I   85   81   79   77   74   71   68   64   60   56   53   50   47   46   46   47   50   54   59   65   71   78   85   92
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 I   82   80   78   75   72   69   65   61   56   52   47   43   40   37   37   38   42   46   52   59   67   75   83   91
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 I   81   79   77   74   71   67   63   58   53   47   42   37   32   29   28   29   32   38   45   53   63   72   82   90
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 I   80   78   76   73   70   66   61   56   50   44   37   31   26   21   19   20   23   30   39   48   59   70   81  152
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 I   80   78   76   73   70   66   61   55   48   41   34   27   20   14   11   11   15   23   33   45   58   70  137  156
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 I   80   78   76   73   70   66   61   55   48   40   32   23   16    9    5    5    8   17   29   43   58  120  143  163
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 I   80   78   76   74   71   67   62   56   49   41   32   23   14    6    1    1    5   15   29   45  102  128  152  173
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 I   80   79   77   75   72   69   64   58   51   43   34   25   15    7    2    1    6   17   33   85  115  143  167  189
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 I   80   79   78   77   74   71   67   62   56   48   39   30   21   13    8    8   14   44   74  105  136  164  189  209
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 I   80   80   80   79   77   75   71   67   62   55   48   40   32   25   22   23   50   73  106  137  167  194  216  234
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
20 I   80   81   81   81   80   79   76   73   69   65   59   53   47   43   41   74   90  116  151  181  208  231  250  264
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
19 I   80   81   82   83   83   83   82   81   78   76   72   69   66   65  112  123  142  171  206  234  256  274  288  298
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
18 I   79   81   83   84   86   87   88   88   88   88   87   87   88  151  161  178  202  232  266  292  308  320  329  333
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
17 I   74   80   83   85   88   91   93   95   98  100  102  176  184  196  212  235  262  294  326  350  361  367  369  369
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
16 I   76   79   82   86   90   94   98  102  107  112  195  206  220  238  261  288  319  350  380  403  409  410  408  403
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
15 I   73   76   80   85   90   95  101  107  114  203  217  234  253  277  304  335  367  398  426  447  450  448  442  433
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
14 I   69   73   78   83   89   96  103  111  200  217  235  257  281  309  340  373  407  437  462  480  483  479  471  459
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
13 I   64   68   74   80   87   95  172  189  207  227  250  275  303  335  368  403  437  466  489  505  508  503  494  461
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
12 I   59   63   68   75   83  153  170  189  210  234  260  288  320  354  389  425  458  487  508  522  525  520  510  497
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
11 I   52   56   62   69  129  145  164  186  210  236  265  297  331  366  403  439  472  500  520  532  536  532  522  508
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
10 I   45   49   54  102  117  135  156  180  206  235  267  301  337  374  411  447  480  506  526  538  541  537  528  515
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 9 I   37   41   77   83  104  123  145  171  199  231  265  301  338  377  414  450  482  508  527  538  542  539  531  516
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 8 I   47   55   63   75   90  109  132  159  190  223  259  297  336  375  413  449  480  505  524  535  539  537  530  519
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 7 I   37   41   49   60   75   95  119  147  179  214  252  291  331  371  409  444  475  499  517  528  533  532  526  516
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 6 I   26   29   36   47   62   81  105  134  167  203  242  283  324  364  402  437  466  491  508  520  525  525  520  511
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 5 I   16   19   25   35   49   68   93  122  155  192  232  273  315  355  393  427  456  479  497  504  516  517  512  505
   I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 4 I    8   11   16   25   39   58   82  111  144  182  222  263  304  344  382  415  443  467  484  496  504  506  504  497
```

C35

```
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  3 I    3    5   10   18   32   50   73  102  135  172  212  253  294  333  369  402  430  453  470  483  492  497  494  488
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  2 I    0    2    6   15   27   45   68   96  128  164  203  243  283  321  357  388  416  438  456  469  479  465  484  479
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  1 I    0    1    6   14   26   43   65   92  123  158  196  234  273  309  344  375  401  424  442  455  466  473  474  470
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
      -------------------------------------------------------------------------------------------------------------------------

         1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

UPPER LEVEL WIND U-FIELD (M/S)                                           YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -2

 30 I  431  432  433  434  435  435  436  436  435  434  433  431  429  426  422  418  413  407  402  395  389  383  377  371
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 29 I  431  433  434  435  436  436  437  436  436  435  433  431  428  425  421  416  410  404  398  391  385  378  372  366
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 28 I  432  433  434  435  436  437  437  437  436  435  433  430  427  423  418  413  407  400  393  386  379  372  366  359
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 27 I  432  433  434  435  436  436  436  436  435  434  432  429  425  420  415  409  402  395  388  380  373  365  359  352
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 26 I  431  433  433  434  435  435  435  435  434  432  429  426  422  417  411  404  397  389  381  373  365  358  351  345
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 25 I  430  431  432  433  433  434  433  433  431  429  426  422  417  412  405  397  389  381  373  364  357  349  342  336
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 24 I  428  429  430  431  431  431  430  429  427  425  421  417  411  405  397  389  381  372  363  355  347  340  333  328
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 23 I  426  426  427  428  428  427  426  424  422  419  415  410  404  396  388  380  371  362  353  344  337  330  324  318
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 22 I  423  423  423  424  423  422  421  419  416  412  407  401  394  387  378  369  360  350  342  333  326  319  314  309
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 21 I  419  419  419  419  418  416  414  411  408  403  398  391  384  375  366  357  348  338  330  322  315  309  304  300
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 20 I  414  414  414  413  411  409  407  403  399  393  387  380  372  363  354  344  335  326  318  310  304  299  295  292
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 19 I  409  409  408  406  404  402  398  394  389  383  376  368  360  351  341  332  323  314  306  300  294  290  286  284
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 18 I  403  402  401  399  396  393  389  384  378  371  364  356  347  338  329  319  311  303  296  290  285  281  279  277
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 17 I  397  396  394  391  388  384  379  374  367  360  352  344  335  326  317  308  300  293  286  281  277  274  272  271
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 16 I  391  389  386  383  379  374  369  363  356  349  341  332  323  314  306  298  290  284  278  274  271  268  267  266
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 15 I  384  381  378  375  370  365  359  353  346  338  330  321  313  304  296  289  282  276  272  268  265  264  263  263
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 14 I  377  374  370  366  361  356  350  343  336  328  320  312  304  296  288  282  276  271  267  263  261  260  260  260
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 13 I  370  367  363  358  353  347  341  334  327  319  311  304  296  289  282  276  270  266  263  260  258  258  258  256
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 12 I  363  359  355  350  345  339  333  326  319  311  304  297  289  283  277  271  267  263  260  258  257  256  256  257
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 11 I  357  353  348  343  338  332  325  319  312  305  298  291  284  278  273  268  264  261  258  257  256  255  256  257
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 10 I  350  346  342  337  331  325  319  313  306  299  293  286  280  275  270  266  262  260  257  256  255  255  256  257
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  9 I  345  340  336  331  325  319  313  307  301  295  289  283  278  273  268  265  261  259  257  256  256  256  256  257
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  8 I  339  335  330  325  320  314  309  303  297  291  286  280  275  271  267  264  261  259  258  257  257  257  257  258
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  7 I  334  330  325  320  315  310  304  299  294  286  283  278  274  270  267  264  261  259  258  258  258  258  258  259
    I    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
```

C36

```
 6 | 330  325  321  316  311  306  301  296  291  286  281  277  273  270  266  264  262  260  259  259  259  259  260  261
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 5 | 326  322  317  313  308  303  298  294  289  284  280  276  273  269  267  264  263  262  261  260  260  261  261  262
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 4 | 322  318  314  309  305  300  296  292  287  283  279  276  272  269  267  265  264  263  262  262  262  262  263  264
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 3 | 319  315  311  307  302  298  294  290  286  282  279  275  272  270  268  266  265  265  264  264  264  264  265  266
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 2 | 316  312  308  304  300  296  292  289  285  281  278  275  272  270  269  268  267  266  266  265  266  266  266  267
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 1 | 313  310  306  302  299  295  291  288  284  281  278  275  273  272  270  269  268  268  267  267  267  268  268  269
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
    ------------------------------------------------------------------------------------------------------------------------

      1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24

UPPER LEVEL WIND V-FIELD (M/S)                                     YEAR: 78  MONTH:  8  DAY: 23  JULIAN DAY: 235  HOUR: 23

MULTIPLY ALL VALUES BY 10 **  -2

30 | 152  151  151  150  150  149  149  149  149  150  151  152  153  155  157  160  163  166  170  173  177  181  184  188
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 | 152  151  150  150  149  149  149  149  149  149  150  152  153  156  158  161  164  168  172  176  180  184  188  191
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 | 152  151  150  149  149  149  148  148  149  150  151  152  154  157  159  163  166  170  175  179  183  187  191  195
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 | 152  151  150  149  149  149  149  149  149  150  151  153  155  158  161  165  169  173  178  183  187  191  196  199
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 | 152  151  150  150  149  149  149  150  150  151  153  155  157  161  164  168  173  177  182  187  192  196  200  204
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 | 152  152  151  151  150  150  150  151  152  153  155  157  160  164  168  172  177  182  187  192  197  201  205  209
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 | 154  153  153  152  152  152  152  153  154  156  158  161  164  168  172  177  182  187  193  198  203  207  211  214
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 | 155  155  154  154  154  154  155  156  157  159  162  165  168  173  178  183  188  194  199  204  209  213  217  220
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 | 157  157  156  156  157  157  158  159  161  164  166  170  174  179  184  189  195  200  206  211  215  219  223  225
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 | 159  159  159  159  160  161  162  164  166  169  172  176  180  185  191  196  202  208  213  218  222  225  228  231
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
20 | 162  162  162  163  164  165  167  169  171  175  178  183  188  193  198  204  210  215  220  225  228  232  234  236
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
19 | 165  165  166  167  168  170  172  174  177  181  185  190  195  200  206  212  217  222  227  231  234  237  239  241
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
18 | 168  169  170  171  173  175  177  180  184  188  192  197  203  208  214  219  224  229  233  237  240  242  244  245
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
17 | 172  173  174  176  178  180  183  187  190  195  199  205  210  215  221  226  231  235  239  242  245  246  248  248
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
16 | 176  177  179  181  183  186  189  193  197  202  206  212  217  222  227  232  237  241  244  247  249  250  251  251
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
15 | 180  182  184  186  189  192  195  199  203  208  213  218  223  228  233  238  242  245  248  250  252  253  253  253
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
14 | 184  186  188  191  194  197  201  205  209  214  219  224  229  233  238  242  246  249  251  253  254  255  255  255
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
13 | 189  191  193  196  199  202  206  210  215  219  224  229  233  238  242  246  249  251  253  255  256  256  256  256
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
12 | 193  195  198  201  204  207  211  215  220  224  229  233  237  241  245  248  251  253  255  256  257  257  257  257
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
11 | 197  199  202  205  208  212  216  220  224  228  232  236  240  244  247  250  253  255  256  257  258  258  258  257
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
10 | 200  203  206  209  212  216  219  223  227  231  235  239  243  246  249  252  254  255  257  257  258  258  258  257
   |   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
 9 | 204  207  209  212  216  219  223  227  230  234  238  241  244  247  250  252  254  256  257  257  258  258  257  257
```

(3)

```
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
8 I 207   210   213   216   219   222   226   229   233   236   240   243   246   248   251   253   254   256   257   257   257   257   257   256
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
7 I 210   213   216   219   222   225   228   231   235   238   241   244   247   249   251   253   254   255   256   256   256   256   256   255
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
6 I 213   216   218   221   224   227   230   233   236   239   242   245   247   249   251   253   254   255   255   256   256   256   255   255
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
5 I 215   218   221   223   226   229   232   235   238   240   243   245   247   249   251   253   254   254   255   255   255   255   254   254
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
4 I 218   220   223   225   228   231   233   236   239   241   243   246   248   249   251   252   253   253   254   254   254   254   253   253
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
3 I 220   222   224   227   229   232   234   237   239   242   244   246   248   249   250   251   252   252   253   253   253   253   252   252
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
2 I 221   224   226   228   231   233   235   238   240   242   244   246   248   249   250   250   251   251   252   252   252   251   251   251
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
1 I 223   225   227   230   232   234   236   238   240   242   244   246   247   248   249   249   250   250   251   251   251   250   250   250
  I  +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
  ----------------------------------------------------------------------------------------------------------------------------------------------

     1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20    21    22    23    24
```

APPENDIX D

MESOPUFF II TEST CASE INPUTS/OUTPUT

MESOPUFF II Card-Image Inputs:

```
MESOPUFF II - TEST CASE RUN
   78  235    0   24    1    0  125    2
    1    1    2    T   2.    T  900
    1   24    1   30   15   24   11   22    1
    T    T    T    T    T
    T    T   12    F    0    0
0000000000
15.2 11.36 305. 9.45 20.0 439.   12420.7        37.3      0.        0.        0.
     15.40     11.66            NETWORK 1 - MONITOR # 1
     16.31     12.86                                # 3
     16.71     12.23                                # 5
     15.23     11.29                                # 6
     14.89     10.81                                # 7
     14.78     11.61                                # 8
     14.38     12.03                                # 9
     15.49     10.98                                # 10
     15.14     11.68                                # 12
     14.62     11.20                                # 13
     15.54     11.86                                # 18
     16.93     12.38                                # 19
     19.16     17.91            NETWORK 2 - MONITOR # 1
     19.87     18.53                                # 4
     19.22     18.01                                # 9
     19.29     18.13                                # 12
     19.36     18.22                                # 13
     18.23     17.96                                # 16
     19.54     17.40                                # 18
     18.86     17.86                                # 19
     19.30     17.33                                # 21
     18.62     17.47                                # 22
     18.93     18.12                                # 23
     19.08     17.21                                # 24
   10.219    11.796                     75 KM RING - 275 DEG.
   10.276    12.228                                  280
   10.370    12.654                                  285
   10.502    13.070                                  290
   10.668    13.473                                  295
   10.870    13.860                                  300
   11.104    14.228                                  305
   11.370    14.574                                  310
   11.664    14.896                                  315
   11.986    15.190                                  320
   12.332    15.456                                  325
   12.700    15.690                                  330
   13.087    15.892                                  335
   13.490    16.058                                  340
   13.906    16.190                                  345
   14.332    16.284                                  350
   14.764    16.341                                  355
   15.200    16.360                                  360
   15.636    16.341                                    5
   16.068    16.284                                   10
   16.494    16.190                                   15
   16.910    16.058                                   20
   17.313    15.892                                   25
   17.700    15.690                                   30
   18.068    15.456                                   35
   18.414    15.190                                   40
   18.736    14.896                                   45
   19.030    14.574                                   50
   19.296    14.228                                   55
   19.530    13.860                                   60
   19.732    13.473                                   65
```

```
  19.898    13.070                             70
  20.030    12.654                             75
  20.124    12.228                             80
  20.181    11.796                             85
  20.200    11.360                             90
   7.895    11.999         110 KM RING - 275 DEG.
   7.978    12.633                            280
   8.117    13.258                            285
   8.309    13.868                            290
   8.554    14.459                            295
   8.849    15.027                            300
   9.193    15.566                            305
   9.582    16.074                            310
  10.015    16.545                            315
  10.486    16.978                            320
  10.994    17.367                            325
  11.533    17.711                            330
  12.101    18.006                            335
  12.692    18.251                            340
  13.302    18.443                            345
  13.927    18.582                            350
  14.561    18.665                            355
  15.200    18.693                            360
  15.839    18.665                              5
  16.473    18.582                             10
  17.098    18.443                             15
  17.708    18.251                             20
  18.299    18.006                             25
  18.867    17.711                             30
  19.406    17.367                             35
  19.914    16.978                             40
  20.385    16.545                             45
  20.818    16.074                             50
  21.207    15.566                             55
  21.551    15.027                             60
  21.846    14.459                             65
  22.091    13.868                             70
  22.283    13.258                             75
  22.422    12.633                             80
  22.505    11.999                             85
  22.533    11.360                             90
   4.574    12.290         160 KM RING - 275
   4.695    13.212                            280
   4.897    14.121                            285
   5.177    15.008                            290
   5.533    15.868                            295
   5.962    16.693                            300
   6.462    17.478                            305
   7.029    18.216                            310
   7.658    18.902                            315
   8.344    19.531                            320
   9.082    20.098                            325
   9.867    20.598                            330
  10.692    21.027                            335
  11.552    21.383                            340
  12.439    21.663                            345
  13.348    21.865                            350
  14.270    21.986                            355
  15.200    22.027                            360
  16.130    21.986                              5
  17.052    21.865                             10
  17.961    21.663                             15
  18.848    21.383                             20
```

19.708	21.027	25
20.533	20.598	30
21.318	20.098	35
22.056	19.531	40
22.742	18.902	45
23.371	18.216	50
23.938	17.478	55

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MESOPUFF II TEST CASE OUTPUT

```
                                                         MESOPUFF   VERSION  1.0   LEVEL 821201
**************************************************************************************************************************

MESOPUFF II - TEST CASE RUN

GENERAL RUN INFORMATION:

     YEAR OF RUN (NSYR) = 78
     JULIAN DAY OF START OF RUN (NSDAY) = 235
     HOUR OF START OF RUN (NSHR) =  0
     LENGTH OF RUN (NADVTS) =   24 (HOURS)
     NUMBER OF POINT SOURCES (NPTS) =  1
     NUMBER OF AREA (URBAN) SOURCES (NAREAS) =  0
     NUMBER OF NONGRIDDED RECEPTORS (NREC) = 125
     NUMBER OF POLLUTANT SPECIES (NSPEC) =  2

COMPUTATIONAL VARIABLES:

     CONCENTRATION AVERAGING TIME (IAVG) =    1 (HOUR(S))
     PUFF RELEASE RATE (NPUF) =   1 (PUFFS/HOUR)
     MINIMUM SAMPLING RATE (NSAMAD) =  2 (SAMPLES/HOUR)
     SAMPLING RATE VARIED WITH WIND SPEED ? (LVSAMP) = T
     SAMPLING RATE WIND SPEED INTERVAL (WSAMP) =  2.00 (M/S)
     CONCENTRATIONS CALCULATED AT SAMPLING GRID POINTS ? (LSGRID) = T
     PUFFS YOUNGER THAN "AGEMIN" SECONDS ARE NOT SAMPLED (AGEMIN) =   900. (SECONDS)

GRID INFORMATION:

     BEGINNING OF COMPUTATIONAL GRID IN X-DIRECTION (IASTAR) =  1
     END OF COMPUTATIONAL GRID IN X-DIRECTION (IASTOP) = 24
     BEGINNING OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTAR) =  1
     END OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTOP) = 30
     BEGINNING OF SAMPLING GRID IN X-DIRECTION (ISASTR) = 15
     END OF SAMPLING GRID IN X-DIRECTION (ISASTP) = 24
     BEGINNING OF SAMPLING GRID IN Y-DIRECTION (JSASTR) = 11
     END OF SAMPLING GRID IN Y-DIRECTION (JSASTP) = 22
     SAMPLING GRID SPACING FACTOR (MESHDN) =  1

TECHNICAL OPTIONS:

     GAUSSIAN VERTICAL CONCENTRATION DISTRIBUTION ? (LGAUSS) = T
     CHEMICAL PROCESSES MODELED ? (LCHEM) = T
     DRY DEPOSITION MODELED ? (LDRY) = T
     WET REMOVAL MODELED ? (LWET) = T
     3 VERTICAL LAYERS ? (L3VL) = T

OUTPUT OPTIONS:

     CONCENTRATIONS STORED ON TAPE ? (LTAPE) = T
     CONCENTRATIONS PRINTED ? (LPRINT) = T
     PRINT INTERVAL (IPRINF) =   12
     PUFF PARAMETERS PRINTED EACH SAMPLING STEP ? (LDB) = F
     TIME STEPS FOR WHICH PUFF PARAMETERS PRINTED (NN1,NN2) =    0,   0
```

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```
                                                            MESUPUFF   VERSION  1.0   LEVEL 821201
**************************************************************************************************************************

DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)
    USER INPUT SIGY, SIGZ VARIABLES (IOPTS(1)) =                   0
    USER INPUT VERTICAL DIFFUSIVITY CONSTANTS (IOPTS(2)) =         0
    USER INPUT DRY DEP. SO2 CANOPY RESISTANCES (IOPTS(3)) =        0
    USER INPUT OTHER DRY DEP. CONSTANTS (IOPTS(4)) =               0
    USER INPUT WET REMOVAL CONSTANTS (IOPTS(5)) =                  0
    USER INPUT CHEMICAL TRANSFORMATION VARIABLES (IOPTS(6)) =      0

SIGY, SIGZ VARIABLES:
    AY =                .36000    .25000    .19000    .13000    .09600    .06300
    BY =                .90000    .90000    .90000    .90000    .90000    .90000
    AZ =                .00023    .05800    .11000    .57000    .85000    .77000
    BZ =               2.10000   1.09000    .91000    .58000    .47000    .42000
    AZT (IN M) =       5.00000   3.87300   2.73900   1.87100   1.22500    .70700
    TMDEP =      100000. (M)
    STABILITY CLASS USED IN SIGY, SIGZ CALCULATIONS FOR PUFFS ABOVE BOUNDARY LAYER (JSUP) =  5
         (0 = BOUNDARY LAYER STABILITY CLASS, 5 = E STABILITY, 6 = F STABILITY)

VERTICAL DIFFUSIVITY CONSTANTS:
    CON1K =        .010 (M**2/S)
    CON2K =        .100 (M**2/S)

LAND USE CATEGORY   SO2 CANOPY RESISTANCE (S/M)
                      A,B,C        D         E          F
        1            100.00    300.00   1000.00        .00
        2            100.00    300.00   1000.00        .00
        3            100.00    300.00   1000.00        .00
        4            100.00    300.00   1000.00        .00
        5            100.00    300.00   1000.00        .00
        6            100.00    300.00   1000.00        .00
        7            100.00    300.00   1000.00        .00
        8            200.00    500.00   1000.00    1000.00
        9             50.00     75.00    100.00        .00
       10             75.00    300.00   1000.00        .00
       11           1000.00   1000.00   1000.00        .00
       12               .00       .00       .00        .00

DRY DEPOSITION CONSTANTS:
    CANOPY RESISTANCE FOR NOX IN S/M (RCNOX) =  130.00 (A,B,C)   500.00 (D)  1500.00 (E)  1500.00 (F)
    SURFACE RESISTANCE CONSTANT FOR GASES (RSGCON) =    2.60
    SURFACE RESISTANCE FOR PARTICLES (RSPART) = 1000.00 (S/M)

WET REMOVAL CONSTANTS:
                             SO2         SO4        NOX         HNO3       NO3
    WA (LIQUID PRECIP.)      3.00E-05  1.00E-04  0.00E-01  6.00E-05  1.00E-04
    WA (FROZEN PRECIP.)      0.00E-01  3.00E-05  0.00E-01  0.00E-01  3.00E-05

    WHERE Q/Q0 = EXP(-WA * (P/P0) * DT)
          Q0 IS POLLUTANT MASS IN PUFF AT TIME T
          Q IS POLLUTANT MASS IN PUFF AT TIME T + DT
          WA IS THE WET REMOVAL CONSTANT (1/S)
          P IS THE PRECIPITATION RATE (MM/HR)
          P0 IS A REFERENCE PRECIPITATION RATE OF 1 MM/HR
          DT IS THE SAMPLING INTERVAL
```

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```
CHEMICAL TRANSFORMATION VARIABLES:
    SOX TRANSFORMATION METHOD FLAG (MSOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
        3 - GILLANI EQUATION
        4 - HENRY EQUATION FOR ST. LOUIS
        5 - HENRY EQUATION FOR LOS ANGELES
    NOX TRANSFORMATION METHOD FLAG (MNOX) =  2
        0 - NO TRANSFORMATION
        1 - USER SPECIFIED
        2 - ERT THEORETICAL EQUATION
    OZONE INPUT METHOD FLAG (MO3) =  0
        0 - DEFAULT OZONE VALUE USED
        1 - HOURLY OZONE VALUES READ
    DEFAULT BACKGROUND OZONE (CO3B) =   80.0 (PPB)
    TOTAL AMMONIA CONCENTRATION (CTNH3) =   10.0 (PPB)
    NIGHTTIME TRANSFORMATION RATES:
        SO2 LOSS RATE (RNITE(1)) =    .2 (%/HOUR)
        NOX LOSS RATE (RNITE(2)) =   2.0 (%/HOUR)
        TOTAL NO3 FORMATION RATE (RNITE(3)) =   2.0 (%/HOUR)
```

```
                                                MESOPUFF   VERSION  1.0   LEVEL 821201
*************************************************************************************************************************

POINT SOURCE DATA

SOURCE     GRID COORDINATES    STACK HT    DIAMETER    EXIT VEL.    TEMP.    ------------- EMISSION RATES (G/S) -------------
             X         Y         (M)         (M)        (M/S)     (DEG K)       SO2        SO4        NOX       HNO3       NO3

  1        15.20     11.36     305.00       9.45       20.00      439.00   12420.70     37.30        .00        .00       .00
```

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```
                                                                  MESOPUFF   VERSION  1.0   LEVEL 821201
**************************************************************************************************************************************

     NONGRIDDED RECEPTOR LOCATIONS

RECEPTOR     X (GRID UNITS)     Y (GRID UNITS)

     1            15.400             11.660
     2            16.310             12.860
     3            16.710             12.230
     4            15.230             11.290
     5            14.890             10.810
     6            14.780             11.610
     7            14.380             12.030
     8            15.490             10.980
     9            15.140             11.680
    10            14.620             11.200
    11            15.540             11.860
    12            16.930             12.380
    13            19.160             17.910
    14            19.870             18.530
    15            19.220             18.010
    16            19.290             18.130
    17            19.360             18.220
    18            18.230             17.960
    19            19.540             17.400
    20            18.860             17.860
    21            19.300             17.330
    22            18.620             17.470
    23            18.930             18.120
    24            19.080             17.210
    25            10.219             11.796
    26            10.276             12.228
    27            10.370             12.654
    28            10.502             13.070
    29            10.668             13.473
    30            10.870             13.860
    31            11.104             14.228
    32            11.370             14.574
    33            11.664             14.896
    34            11.986             15.190
    35            12.332             15.456
    36            12.700             15.690
    37            13.087             15.892
    38            13.490             16.058
    39            13.906             16.190
    40            14.332             16.284
    41            14.764             16.341
    42            15.200             16.360
    43            15.636             16.341
    44            16.068             16.284
    45            16.494             16.190
    46            16.910             16.058
    47            17.313             15.892
    48            17.700             15.690
    49            18.068             15.456
    50            18.414             15.190
    51            18.736             14.896
```

```
                                                    MESOPUFF    VERSION  1.0    LEVEL 821201
****************************************************************************************************************************************

    NONGRIDDED RECEPTOR LOCATIONS

RECEPTOR     X (GRID UNITS)     Y (GRID UNITS)

    52          19.030              14.574
    53          19.296              14.228
    54          19.530              13.860
    55          19.732              13.473
    56          19.898              13.070
    57          20.030              12.654
    58          20.124              12.228
    59          20.181              11.796
    60          20.200              11.360
    61           7.895              11.999
    62           7.978              12.633
    63           8.117              13.258
    64           8.309              13.868
    65           8.554              14.459
    66           8.849              15.027
    67           9.193              15.566
    68           9.582              16.074
    69          10.015              16.545
    70          10.486              16.978
    71          10.994              17.367
    72          11.533              17.711
    73          12.101              18.006
    74          12.692              18.251
    75          13.302              18.443
    76          13.927              18.582
    77          14.561              18.665
    78          15.200              18.693
    79          15.839              18.665
    80          16.473              18.582
    81          17.098              18.443
    82          17.708              18.251
    83          18.299              18.006
    84          18.867              17.711
    85          19.406              17.367
    86          19.914              16.978
    87          20.385              16.545
    88          20.818              16.074
    89          21.207              15.566
    90          21.551              15.027
    91          21.846              14.459
    92          22.091              13.868
    93          22.283              13.258
    94          22.422              12.633
    95          22.505              11.999
    96          22.533              11.360
    97           4.574              12.290
    98           4.695              13.212
    99           4.897              14.121
   100           5.177              15.008
   101           5.533              15.868
   102           5.962              16.693
   103           6.462              17.478
   104           7.029              18.216
   105           7.658              18.902
   106           8.344              19.531
```

```
107        9.082      20.098
108        9.867      20.598
109       10.692      21.027
110       11.552      21.383
111       12.439      21.663
112       13.348      21.865
113       14.270      21.986
114       15.200      22.027
115       16.130      21.986
116       17.052      21.865
117       17.961      21.663
118       18.848      21.383
119       19.708      21.027
120       20.533      20.598
121       21.318      20.098
122       22.056      19.531
123       22.742      18.902
124       23.371      18.216
125       23.938      17.478
```

```
                                                  MESUPUFF   VERSION  1.0   LEVEL 821201
************************************************************************************************************************************

INFORMATION READ FROM METEOROLOGICAL DATA FILE:

    YEAR OF METEOROLOGICAL DATA = 78
    METEOROLOGICAL DATA BEGINS ON JULIAN DAY 235
    NUMBER OF HOURS OF METEOROLOGICAL DATA =   25

    METEOROLOGICAL GRID SIZE IN X (WEST-EAST) DIRECTION = 24
    METEOROLOGICAL GRID SIZE IN Y (SOUTH-NORTH) DIRECTION = 30
    METEOROLOGICAL GRID SPACING =     15000.0 (M)
    BASE TIME ZONE = 6 (C.S.T.)

    VON KARMAN CONSTANT =  .40
    CODE FOR LOWER-LEVEL WIND FIELD (ILWF) =  2
    CODE FOR UPPER-LEVEL WIND FIELD (IUWF) =  4

    NUMBER OF STATIONS USED IN CONSTRUCTION OF METEOROLOGICAL DATA FIELDS
          SURFACE:      3
          RAWINSONDE:  2

    STATION         GRID COORDINATES
       TYPE              X              Y
                  (GRID UNITS)  (GRID UNITS)

    SURFACE         1.00           1.40
    SURFACE        15.70          23.60
    SURFACE        21.00           9.30
    RAWINSONDE      7.10          28.00
    RAWINSONDE     21.70          10.30
```

D11

```
                                                    MESOPUFF   VERSION  1.0   LEVEL 821201
*********************************************************************************************************************

SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **  -2

30 I 30  30  30  30  30  30  30  30  30  30  30  20  30  30  30  30  30  30  90  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
29 I 30  30  30  30  30  30  30  30  30  20  20  20  30  30  30  30  30  30  90  90  90  30  90  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
28 I 20  20  30  30  30  30  30  30  30  30  30  20  30  30  20  30  30  30  90  90  90  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
27 I 20  20  30  30  30  30  30  30  30  30  30  20  30  30  20  30  30  30  90  90  90  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
26 I 30  30  30  30  30  30  30  30  30  30  30  30  20  20  20  30  30  30  30  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
25 I 30  30  30  30  30  20  30  30  30  30  30  20  30  30  20  30  30  30  30  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
24 I 30  30  20  30  30  20  30  30  30  30  30  20  20  20  30  30  30  30  30  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
23 I 40  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  90  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
22 I 30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  90  90  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
21 I 30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  30  90  90  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
20 I 30  30  30  90  90  30  30  30  30  90  90  30  30  30  90  30  30  30  90  90  90  90  90  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
19 I 30  30  30  90  90  30  30  30  30  30  30  30  90  90  30  90  90  90  90  90  90  90  90  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
18 I 30  30  30  90  90  30  30  30  30  30  30  30  90  90  90  90  90  90  90  90  90  90  90  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
17 I 30  30  30  30  30  30  20  20  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
16 I 30  30  30  30  30  30  20  20  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
15 I 30  30  30  30  30  30  30  30  30  30  30  90  90  90  30  30  30  90  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
14 I 20  20  20  30  30  30  30  30  30  30  30  90  90  90  30  30  30  30  90  90  30  30  30  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
13 I 20  20  30  90  90  30  30  30  30  30  30  90  90  90  30  30  30  30  30  30  30  30  30  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
12 I 20  20  30  30  30  30  30  30  30  30  30  90  90  90  90  90  90  30  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
11 I 20  20  30  30  30  30  30  30  30  30  30  90  90  90  90  90  90  30  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
10 I 20  20  30  30  30  30  30  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 9 I 20  20  30  30  30  30  30  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 8 I 30  30  90  30  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 7 I 90  90  30  30  30  30  30  90  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 6 I 90  90  30  30  30  30  30  90  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 5 I 90  90  30  30  30  30  30  90  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 4 I 30  30  30  30  30  30  30  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  30  90
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 3 I 90  90  30  30  30  90  90  90  90  90  90  90  90  90  90  90  30  30  30  30  30  30  30  30
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
2 | 30   30   30   30   30   90   90   90   90   90   30   90   90   90   90   90   30   30   30   30   30   30   30   90
  |  +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
1 | 30   30   30   30   30   90   90   90   90   90   30   90   90   90   90   90   30   30   30   30   30   30   30   90
  |  +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
  ------------------------------------------------------------------------------------------------------------------------

     1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24
```

```
****************************************************************** MESOPUFF   VERSION  1.0   LEVEL 821201 ******************************************************************

STATION NUMBER OF CLOSEST SURFACE MET. STATION TO EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **   0

30 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
29 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
28 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
27 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
26 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
25 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
24 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
23 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
22 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I 1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I 1  1  1  2  2  2  2  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I 1  1  1  1  2  2  2  2  2  2  2  2  2  2  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I 1  1  1  1  1  1  2  2  2  2  2  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I 1  1  1  1  1  1  1  2  2  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I 1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I 1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I 1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I 1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I 1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 7 I 1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 6 I 1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 5 I 1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 4 I 1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 3 I 1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3  3
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
2 I  1  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3
  I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
1 I  1  1  1  1  1  1  1  1  1  1  1  1  3  3  3  3  3  3  3  3  3  3  3  3
  I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
    ------------------------------------------------------------------------

     1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
```

D15

```
                                                     MESOPUFF   VERSION  1.0   LEVEL 821201
************************************************************************************************************************

LAND USE CATEGORIES FOR EACH GRID POINT

MULTIPLY ALL VALUES BY 10 **    0

30 I 2  2  2  2  2  2  2  2  2  2  2  1  2  2  2  2  2  2  4  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
29 I 2  2  2  2  2  2  2  2  2  1  1  1  2  2  2  2  2  2  4  4  4  2  4  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
28 I 1  1  2  2  2  2  2  2  2  2  2  1  2  2  1  2  2  2  4  4  4  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
27 I 1  1  2  2  2  2  2  2  2  2  2  1  2  2  1  2  2  2  4  4  4  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
26 I 2  2  2  2  2  2  2  2  2  2  2  2  1  1  1  2  2  2  2  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
25 I 2  2  2  2  2  1  2  2  2  2  2  1  2  2  1  2  2  2  2  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
24 I 2  2  1  2  2  1  2  2  2  2  2  1  1  1  2  2  2  2  2  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
23 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  4  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
22 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  4  4  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I 2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  2  4  4  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I 2  2  2  4  4  2  2  2  2  4  4  2  2  2  4  2  2  2  4  4  4  4  4  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I 2  2  2  4  4  2  2  2  2  2  2  2  4  4  2  4  4  4  4  4  4  4  4  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I 2  2  2  4  4  2  2  2  2  2  2  2  4  4  4  4  4  4  4  4  4  4  4  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I 2  2  2  2  2  2  1  1  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I 2  2  2  2  2  2  1  1  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I 2  2  2  2  2  2  2  2  2  2  2  4  4  4  2  2  2  4  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I 1  1  1  2  2  2  2  2  2  2  2  4  4  4  2  2  2  2  4  4  2  2  2  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I 1  1  2  4  4  2  2  2  2  2  2  4  4  4  2  2  2  2  2  2  2  2  2  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I 1  1  2  2  2  2  2  2  2  2  2  4  4  4  4  4  4  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I 1  1  2  2  2  2  2  2  2  2  2  4  4  4  4  4  4  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I 1  1  2  2  2  2  2  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I 1  1  2  2  2  2  2  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I 2  2  4  2  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 7 I 4  4  2  2  2  2  2  4  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 6 I 4  4  2  2  2  2  2  4  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 5 I 4  4  2  2  2  2  2  4  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 4 I 2  2  2  2  2  2  2  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  2  4
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 3 I 4  4  2  2  2  4  4  4  4  4  4  4  4  4  4  4  2  2  2  2  2  2  2  2
   I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
```

D16

```
2 I 2  2  2  2  2  4  4  4  4  4  2  4  4  4  4  4  2  2  2  2  2  2  2  4
  I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
1 I 2  2  2  2  2  4  4  4  4  4  2  4  4  4  4  4  2  2  2  2  2  2  2  4
  I +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
    ------------------------------------------------------------------------
    1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
```

D11

```
                                                      MESOPUFF   VERSION  1.0   LEVEL 821201
*************************************************************************************************************************************

GROUND-LEVEL SO2  CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS       YEAR: 78  MONTH:  8  DAY: 23  HOUR: 12

MULTIPLY ALL VALUES BY 10 **  -6

12 I    0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
11 I    0     0     1     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
10 I    1    19    17     2     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 9 I    6    81    60     3     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 8 I   10   144   113     7     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 7 I    0   119    86    11     9     2     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 6 I    8   129    61    66    83     6     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 5 I    0     0    16   109    84     1     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 4 I    0     0    26   136    10     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 3 I    0     0   215     1     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 2 I    0   212     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
 1 I    0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +
     -------------------------------------------------------

        1     2     3     4     5     6     7     8     9    10
```

```
                                                    MESOPUFF   VERSION  1.0   LEVEL 821201
*******************************************************************************************************************************

GROUND-LEVEL SO4  CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS       YEAR: 78  MONTH:  8  DAY: 23  HOUR: 12

MULTIPLY ALL VALUES BY 10 **  -7

12 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
11 I    0    1    2    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
10 I    2   31   39    4    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 9 I   11  169  131    8    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 8 I   18  272  237   16    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 7 I    0  245  188   25   17    4    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 6 I   15  259  120  129  135   11    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 5 I    0    0   28  126   80    1    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 4 I    0    0   21   84    8    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 3 I    0    0  103    1    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 2 I    0   81    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 1 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
    ---------------------------------------------------

        1    2    3    4    5    6    7    8    9   10

GROUND-LEVEL SO2  CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS        YEAR: 78  MONTH:  8  DAY: 23  HOUR: 12

RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION
    1       2.6363E-04           2       9.9451E-06           3       1.2547E-05           4       5.4830E-05
    5       0.0000E-01           6       0.0000E-01           7       0.0000E-01           8       0.0000E-01
    9       0.0000E-01          10       0.0000E-01          11       1.8136E-04          12       9.6591E-06
   13       0.0000E-01          14       0.0000E-01          15       0.0000E-01          16       0.0000E-01
   17       0.0000E-01          18       2.2506E-06          19       1.1929E-06          20       0.0000E-01
   21       2.0876E-06          22       2.7627E-07          23       0.0000E-01          24       3.6099E-06
   25       0.0000E-01          26       0.0000E-01          27       0.0000E-01          28       0.0000E-01
   29       0.0000E-01          30       0.0000E-01          31       0.0000E-01          32       0.0000E-01
   33       0.0000E-01          34       0.0000E-01          35       0.0000E-01          36       0.0000E-01
   37       0.0000E-01          38       0.0000E-01          39       0.0000E-01          40       0.0000E-01
   41       0.0000E-01          42       1.0934E-05          43       1.0226E-04          44       1.7241E-04
   45       7.3362E-05          46       4.6428E-05          47       1.0336E-04          48       7.4805E-05
   49       8.8682E-05          50       1.1421E-04          51       1.0945E-04          52       7.4806E-05
   53       7.9522E-06          54       0.0000E-01          55       0.0000E-01          56       0.0000E-01
   57       0.0000E-01          58       0.0000E-01          59       0.0000E-01          60       0.0000E-01
   61       0.0000E-01          62       0.0000E-01          63       0.0000E-01          64       0.0000E-01
   65       0.0000E-01          66       0.0000E-01          67       0.0000E-01          68       0.0000E-01
   69       0.0000E-01          70       0.0000E-01          71       0.0000E-01          72       0.0000E-01
   73       0.0000E-01          74       0.0000E-01          75       0.0000E-01          76       0.0000E-01
   77       7.1107E-07          78       1.8480E-05          79       9.4763E-05          80       1.3255E-04
   81       7.6574E-05          82       1.9703E-05          83       1.5375E-06          84       0.0000E-01
   85       1.6397E-06          86       3.6753E-06          87       9.8872E-07          88       0.0000E-01
   89       0.0000E-01          90       0.0000E-01          91       0.0000E-01          92       0.0000E-01
   93       0.0000E-01          94       0.0000E-01          95       0.0000E-01          96       0.0000E-01
   97       0.0000E-01          98       0.0000E-01          99       0.0000E-01         100       0.0000E-01
```

D19

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  101      0.0000E-01        102      0.0000E-01        103      0.0000E-01        104      0.0000E-01
  105      0.0000E-01        106      0.0000E-01        107      0.0000E-01        108      0.0000E-01
  109      0.0000E-01        110      0.0000E-01        111      0.0000E-01        112      0.0000E-01
  113      0.0000E-01        114      0.0000E-01        115      0.0000E-01        116      0.0000E-01
  117      0.0000E-01        118      0.0000E-01        119      0.0000E-01        120      0.0000E-01
  121      0.0000E-01        122      0.0000E-01        123      0.0000E-01        124      0.0000E-01
  125      0.0000E-01

GROUND-LEVEL SO4  CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS        YEAR: 78  MONTH:  8  DAY: 23  HOUR: 12

RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION
    1      3.2967E-06            2      3.8048E-07            3      4.3961E-07            4      1.9511E-07
    5      0.0000E-01            6      0.0000E-01            7      0.0000E-01            8      0.0000E-01
    9      0.0000E-01           10      0.0000E-01           11      3.4689E-06           12      3.5744E-07
   13      0.0000E-01           14      0.0000E-01           15      0.0000E-01           16      0.0000E-01
   17      0.0000E-01           18      5.0441E-07           19      2.1017E-07           20      0.0000E-01
   21      3.6648E-07           22      6.1724E-08           23      0.0000E-01           24      6.3647E-07
   25      0.0000E-01           26      0.0000E-01           27      0.0000E-01           28      0.0000E-01
   29      0.0000E-01           30      0.0000E-01           31      0.0000E-01           32      0.0000E-01
   33      0.0000E-01           34      0.0000E-01           35      0.0000E-01           36      0.0000E-01
   37      0.0000E-01           38      0.0000E-01           39      0.0000E-01           40      0.0000E-01
   41      0.0000E-01           42      2.1357E-06           43      2.0508E-05           44      3.5631E-05
   45      1.5606E-05           46      9.3062E-06           47      2.0519E-05           48      1.4436E-05
   49      1.2570E-05           50      1.4456E-05           51      1.0394E-05           52      6.3782E-06
   53      6.8147E-07           54      0.0000E-01           55      0.0000E-01           56      0.0000E-01
   57      0.0000E-01           58      0.0000E-01           59      0.0000E-01           60      0.0000E-01
   61      0.0000E-01           62      0.0000E-01           63      0.0000E-01           64      0.0000E-01
   65      0.0000E-01           66      0.0000E-01           67      0.0000E-01           68      0.0000E-01
   69      0.0000E-01           70      0.0000E-01           71      0.0000E-01           72      0.0000E-01
   73      0.0000E-01           74      0.0000E-01           75      0.0000E-01           76      0.0000E-01
   77      1.3627E-07           78      3.5860E-06           79      1.8779E-05           80      2.7133E-05
   81      1.6201E-05           82      4.3177E-06           83      3.4495E-07           84      0.0000E-01
   85      2.8836E-07           86      6.4736E-07           87      1.7427E-07           88      0.0000E-01
   89      0.0000E-01           90      0.0000E-01           91      0.0000E-01           92      0.0000E-01
   93      0.0000E-01           94      0.0000E-01           95      0.0000E-01           96      0.0000E-01
   97      0.0000E-01           98      0.0000E-01           99      0.0000E-01          100      0.0000E-01
  101      0.0000E-01          102      0.0000E-01          103      0.0000E-01          104      0.0000E-01
  105      0.0000E-01          106      0.0000E-01          107      0.0000E-01          108      0.0000E-01
  109      0.0000E-01          110      0.0000E-01          111      0.0000E-01          112      0.0000E-01
  113      0.0000E-01          114      0.0000E-01          115      0.0000E-01          116      0.0000E-01
  117      0.0000E-01          118      0.0000E-01          119      0.0000E-01          120      0.0000E-01
  121      0.0000E-01          122      0.0000E-01          123      0.0000E-01          124      0.0000E-01
  125      0.0000E-01
```

D20

```
                                                  MESOPUFF   VERSION  1.0   LEVEL 821201
************************************************************************************************************************
GROUND-LEVEL SO2  CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS      YEAR: 78  MONTH:  8  DAY: 24  HOUR:  0

MULTIPLY ALL VALUES BY 10 **  -7

12 I     0     0     0     0     0     0     0     1     4     7
   I     +     +     +     +     +     +     +     +     +     +
11 I     0     0     0     0     0     0     2     8    16    19
   I     +     +     +     +     +     +     +     +     +     +
10 I     0     0     0     0     0     1    13    29    37    28
   I     +     +     +     +     +     +     +     +     +     +
 9 I     0     0     0     0     0    44   147    81    40    20
   I     +     +     +     +     +     +     +     +     +     +
 8 I     0     0     0     0    11   220   385   117    18     6
   I     +     +     +     +     +     +     +     +     +     +
 7 I     0     0     0     0   228   696   113    24     2     1
   I     +     +     +     +     +     +     +     +     +     +
 6 I     0     0     0     2    49    23     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
 5 I     0     0     0   101     0     0     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
 4 I     0     0     0     0     0     0     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
 3 I     0     0     0     0     0     0     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
 2 I     0     0     0     0     0     0     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
 1 I     0     0     0     0     0     0     0     0     0     0
   I     +     +     +     +     +     +     +     +     +     +
    ----------------------------------------------------------

         1     2     3     4     5     6     7     8     9    10
```

D21

```
                                                  MESOPUFF   VERSION  1.0   LEVEL 821201
*****************************************************************************************************************************

GROUND-LEVEL SO4  CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS       YEAR: 78  MONTH:  8  DAY: 24  HOUR:  0

MULTIPLY ALL VALUES BY 10 **  -8

12 I    0    0    0    0    0    0    0    5   11   16
   I    +    +    +    +    +    +    +    +    +    +
11 I    0    0    0    0    0    0    6   24   48   49
   I    +    +    +    +    +    +    +    +    +    +
10 I    0    0    0    0    0    2   29   87  109   75
   I    +    +    +    +    +    +    +    +    +    +
 9 I    0    0    0    0    0   35  137  147  122   58
   I    +    +    +    +    +    +    +    +    +    +
 8 I    0    0    0    0    7  148  296  124   50   19
   I    +    +    +    +    +    +    +    +    +    +
 7 I    0    0    0    0  118  377   82   23    6    2
   I    +    +    +    +    +    +    +    +    +    +
 6 I    0    0    0    0   18   12    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 5 I    0    0    0   16    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 4 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 3 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 2 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
 1 I    0    0    0    0    0    0    0    0    0    0
   I    +    +    +    +    +    +    +    +    +    +
    ---------------------------------------------------

        1    2    3    4    5    6    7    8    9   10

GROUND-LEVEL SO2  CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS        YEAR: 78  MONTH:  8  DAY: 24  HOUR:  0

RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION        RECEPTOR  CONCENTRATION
    1       0.0000E-01             2       0.0000E-01             3       0.0000E-01             4       0.0000E-01
    5       0.0000E-01             6       0.0000E-01             7       0.0000E-01             8       0.0000E-01
    9       0.0000E-01            10       0.0000E-01            11       0.0000E-01            12       0.0000E-01
   13       3.7736E-06            14       7.8295E-06            15       3.3434E-06            16       2.7877E-06
   17       2.9146E-06            18       0.0000E-01            19       5.1298E-05            20       7.5965E-07
   21       3.8071E-05            22       1.0975E-06            23       2.3146E-07            24       2.4402E-05
   25       0.0000E-01            26       0.0000E-01            27       0.0000E-01            28       0.0000E-01
   29       0.0000E-01            30       0.0000E-01            31       0.0000E-01            32       0.0000E-01
   33       0.0000E-01            34       0.0000E-01            35       0.0000E-01            36       0.0000E-01
   37       0.0000E-01            38       0.0000E-01            39       0.0000E-01            40       0.0000E-01
   41       0.0000E-01            42       0.0000E-01            43       0.0000E-01            44       0.0000E-01
   45       0.0000E-01            46       0.0000E-01            47       0.0000E-01            48       0.0000E-01
   49       5.3492E-07            50       1.3280E-05            51       0.0000E-01            52       0.0000E-01
   53       0.0000E-01            54       0.0000E-01            55       0.0000E-01            56       0.0000E-01
   57       0.0000E-01            58       0.0000E-01            59       0.0000E-01            60       0.0000E-01
   61       0.0000E-01            62       0.0000E-01            63       0.0000E-01            64       0.0000E-01
   65       0.0000E-01            66       0.0000E-01            67       0.0000E-01            68       0.0000E-01
   69       0.0000E-01            70       0.0000E-01            71       0.0000E-01            72       0.0000E-01
   73       0.0000E-01            74       0.0000E-01            75       0.0000E-01            76       0.0000E-01
   77       0.0000E-01            78       0.0000E-01            79       0.0000E-01            80       0.0000E-01
   81       0.0000E-01            82       0.0000E-01            83       0.0000E-01            84       2.0512E-06
   85       4.4407E-05            86       7.6493E-05            87       1.2159E-05            88       1.9721E-07
   89       0.0000E-01            90       0.0000E-01            91       0.0000E-01            92       0.0000E-01
   93       0.0000E-01            94       0.0000E-01            95       0.0000E-01            96       0.0000E-01
   97       0.0000E-01            98       0.0000E-01            99       0.0000E-01           100       0.0000E-01
   101       0.0000E-01          102       0.0000E-01          103       0.0000E-01          104       0.0000E-01
   105       0.0000E-01          106       0.0000E-01          107       0.0000E-01          108       0.0000E-01
   109       0.0000E-01          110       0.0000E-01          111       0.0000E-01          112       0.0000E-01
   113       0.0000E-01          114       0.0000E-01          115       0.0000E-01          116       0.0000E-01
   117       0.0000E-01          118       0.0000E-01          119       0.0000E-01          120       1.3147E-07
   121       1.5003E-06          122       4.5922E-06          123       4.5158E-06          124       1.5887E-06
   125       2.5267E-07

GROUND-LEVEL SO4  CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS        YEAR: 78  MONTH:  8  DAY: 24  HOUR:  0

RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION      RECEPTOR  CONCENTRATION
    1        0.0000E-01           2       0.0000E-01           3       0.0000E-01           4       0.0000E-01
    5        0.0000E-01           6       0.0000E-01           7       0.0000E-01           8       0.0000E-01
    9        0.0000E-01          10       0.0000E-01          11       0.0000E-01          12       0.0000E-01
   13        2.1968E-07          14       5.8385E-07          15       2.0273E-07          16       1.8069E-07
   17        1.9542E-07          18       0.0000E-01          19       2.7615E-06          20       4.4071E-08
   21        2.0138E-06          22       5.7104E-08          23       1.6744E-08          24       1.2728E-06
   25        0.0000E-01          26       0.0000E-01          27       0.0000E-01          28       0.0000E-01
   29        0.0000E-01          30       0.0000E-01          31       0.0000E-01          32       0.0000E-01
   33        0.0000E-01          34       0.0000E-01          35       0.0000E-01          36       0.0000E-01
   37        0.0000E-01          38       0.0000E-01          39       0.0000E-01          40       0.0000E-01
   41        0.0000E-01          42       0.0000E-01          43       0.0000E-01          44       0.0000E-01
   45        0.0000E-01          46       0.0000E-01          47       0.0000E-01          48       0.0000E-01
   49        1.1469E-08          50       2.3365E-07          51       0.0000E-01          52       0.0000E-01
   53        0.0000E-01          54       0.0000E-01          55       0.0000E-01          56       0.0000E-01
   57        0.0000E-01          58       0.0000E-01          59       0.0000E-01          60       0.0000E-01
   61        0.0000E-01          62       0.0000E-01          63       0.0000E-01          64       0.0000E-01
   65        0.0000E-01          66       0.0000E-01          67       0.0000E-01          68       0.0000E-01
   69        0.0000E-01          70       0.0000E-01          71       0.0000E-01          72       0.0000E-01
   73        0.0000E-01          74       0.0000E-01          75       0.0000E-01          76       0.0000E-01
   77        0.0000E-01          78       0.0000E-01          79       0.0000E-01          80       0.0000E-01
   81        0.0000E-01          82       0.0000E-01          83       0.0000E-01          84       1.1137E-07
   85        2.3659E-06          86       4.1030E-06          87       6.8421E-07          88       1.4276E-08
   89        0.0000E-01          90       0.0000E-01          91       0.0000E-01          92       0.0000E-01
   93        0.0000E-01          94       0.0000E-01          95       0.0000E-01          96       0.0000E-01
   97        0.0000E-01          98       0.0000E-01          99       0.0000E-01         100       0.0000E-01
  101        0.0000E-01         102       0.0000E-01         103       0.0000E-01         104       0.0000E-01
  105        0.0000E-01         106       0.0000E-01         107       0.0000E-01         108       0.0000E-01
  109        0.0000E-01         110       0.0000E-01         111       0.0000E-01         112       0.0000E-01
  113        0.0000E-01         114       0.0000E-01         115       0.0000E-01         116       0.0000E-01
  117        0.0000E-01         118       0.0000E-01         119       0.0000E-01         120       4.3155E-08
  121        4.0426E-07         122       1.2284E-06         123       1.2990E-06         124       4.9918E-07
  125        7.6360E-08
```

D23

APPENDIX E

MESOFILE II TEST CASE INPUTS/OUTPUT

MESOFILE II Card-Image Inputs:

```
MESOFILE II TEST CASE - NONGRIDDED RECEPTORS
DEFN
 &SAME IPOL=2,IRTYPE=2,IOUT=49,IMAX=10,JMAX=12,&END
FIND
 &SAME IYEAR=78,IDAY=235,IHOUR=1,IGRIDS=24,NUNIT=20,&END
AVRG
 &SAME IRUN=1,AVETM=24,IFORM=2,PRINT=1,APE=0,&END
```

MESOFILE II TEST CASE OUTPUT

```
VERSION NUMBER   1.0
  LEVEL 820922

   MESOFILE II
```

E2

```
DATA READ FROM MESOPUFF OUTPUT FILE -- UNIT:  20  RUNSTREAM:    1
    VERSON=  1.0  LEVEL=821201  NSYR=78  NSDAY=235  NSHR= 0  NADVTS=   24  IAVG=    1  NPUF=  1  NSAMAD=  2  IELMET=24  JELMET=30
    DGRID=  15000.0  IASTAR= 1  IASTOP=24  JASTAR= 1  JASTOP=30  ISASTR=15  ISASTP=24  JSASTR=11  JSASTP=22  MESHDN= 1  NPTS=   1
    NAREAS=   0  NREC= 125  IPRINF=  12  LGAUSS=T  LCHEM=T  LDRY=T  LWET=T  LPRINT=T  L3VL=T  LVSAMP=T  RSAMP=   2.00  LSGMTU=T
    NSPEC= 2
    XREC=15.40 16.31 16.71 15.23 14.89 14.78 14.38 15.49 15.14 14.62 15.54 16.93 19.16 19.87 19.22 19.29 19.36 18.25 19.59 14.86
         19.30 18.62 18.93 19.08 10.22 10.28 10.37 10.50 10.67 10.87 11.10 11.37 11.66 11.99 12.33 12.70 13.09 13.49 13.91 14.33
         14.76 15.20 15.64 16.07 16.49 16.91 17.31 17.70 18.07 18.41 18.74 19.03 19.30 19.53 19.73 19.90 20.03 20.12 20.18 20.20
          7.90  7.98  8.12  8.31  8.55  8.85  9.19  9.58 10.02 10.49 10.99 11.53 12.10 12.69 13.30 13.93 14.56 15.20 15.84 16.47
         17.10 17.71 18.30 18.87 19.41 19.91 20.38 20.82 21.21 21.55 21.85 22.09 22.28 22.42 22.51 22.53  4.57  4.69  4.90  5.18

          5.53  5.96  6.46  7.03  7.66  8.34  9.08  9.87 10.69 11.55 12.44 13.35 14.27 15.20 16.13 17.05 17.96 18.85 19.71 20.53
         21.32 22.06 22.74 23.37 23.94
    YREC=11.66 12.86 12.23 11.29 10.81 11.61 12.03 10.98 11.68 11.20 11.86 12.38 17.91 18.53 18.01 18.13 18.22 17.96 17.40 17.86
         17.33 17.47 18.12 17.21 11.80 12.23 12.65 13.07 13.47 13.86 14.23 14.57 14.90 15.19 15.46 15.69 15.89 16.06 16.19 16.28
         16.34 16.36 16.34 16.28 16.19 16.06 15.89 15.69 15.46 15.19 14.90 14.57 14.23 13.86 13.47 13.07 12.65 12.23 11.80 11.36
         12.00 12.63 13.26 13.87 14.46 15.03 15.57 16.07 16.54 16.98 17.37 17.71 18.01 18.25 18.44 18.58 18.66 18.69 18.66 18.58
         18.44 18.25 18.01 17.71 17.37 16.98 16.54 16.07 15.57 15.03 14.46 13.87 13.26 12.63 12.00 11.36 12.29 13.21 14.12 15.01

         15.87 16.69 17.48 18.22 18.90 19.53 20.10 20.60 21.03 21.38 21.66 21.87 21.99 22.03 21.99 21.87 21.66 21.38 21.03 20.60
         20.10 19.53 18.90 18.22 17.48

NONGRIDDED RECEPTOR CONCENTRATIONS                                          YEAR: 78  DAY: 236  ENDING HOUR:  0  POLLUTANT:  2

 RECEPTOR       CONCENTRATION              RECEPTOR       CONCENTRATION

     1           1.4272E-07                   51            1.0977E-06
     2           1.2669E-07                   52            1.2348E-06
     3           8.1559E-07                   53            9.8354E-07
     4           8.1298E-09                   54            5.6332E-07
     5           0.0000E-01                   55            1.3548E-07
     6           0.0000E-01                   56            8.3648E-09
     7           0.0000E-01                   57            0.0000E-01
     8           0.0000E-01                   58            0.0000E-01
     9           0.0000E-01                   59            0.0000E-01
    10           0.0000E-01                   60            0.0000E-01
    11           1.6911E-07                   61            0.0000E-01
    12           8.1848E-07                   62            0.0000E-01
    13           1.3828E-06                   63            0.0000E-01
    14           1.5566E-06                   64            0.0000E-01
    15           1.4154E-06                   65            0.0000E-01
    16           1.4508E-06                   66            0.0000E-01
    17           1.4769E-06                   67            0.0000E-01
    18           1.4862E-06                   68            0.0000E-01
    19           1.4946E-06                   69            0.0000E-01
    20           1.3678E-06                   70            0.0000E-01
    21           1.3691E-06                   71            0.0000E-01
    22           1.2019E-06                   72            0.0000E-01
    23           1.4510E-06                   73            0.0000E-01
    24           1.2467E-06                   74            0.0000E-01
    25           0.0000E-01                   75            0.0000E-01
    26           0.0000E-01                   76            1.2142E-07
    27           0.0000E-01                   77            5.8136E-07
    28           0.0000E-01                   78            1.0569E-06
    29           0.0000E-01                   79            1.4572E-06
    30           0.0000E-01                   80            1.5602E-06
    31           0.0000E-01                   81            1.5449E-06
    32           0.0000E-01                   82            1.5956E-06
    33           0.0000E-01                   83            1.4849E-06
    34           0.0000E-01                   84            1.3109E-06
    35          0.0000E-01              85          1.4252E-06
    36          0.0000E-01              86          1.8002E-06
    37          0.0000E-01              87          1.4274E-06
    38          0.0000E-01              88          1.3290E-06
    39          5.4817E-08              89          1.1449E-06
    40          8.7320E-07              90          4.6578E-07
    41          1.4066E-06              91          5.6156E-08
    42          1.8176E-06              92          0.0000E-01
    43          2.5645E-06              93          0.0000E-01
    44          2.0121E-06              94          0.0000E-01
    45          7.7065E-07              95          0.0000E-01
    46          4.6790E-07              96          0.0000E-01
    47          8.9625E-07              97          0.0000E-01
    48          6.8756E-07              98          0.0000E-01
    49          1.4135E-06              99          0.0000E-01
    50          1.5476E-06             100          0.0000E-01

 RECEPTOR     CONCENTRATION

   101          0.0000E-01
   102          0.0000E-01
   103          0.0000E-01
   104          0.0000E-01
   105          0.0000E-01
   106          0.0000E-01
   107          0.0000E-01
   108          0.0000E-01
   109          0.0000E-01
   110          0.0000E-01
   111          0.0000E-01
   112          0.0000E-01
   113          0.0000E-01
   114          0.0000E-01
   115          0.0000E-01
   116          5.8459E-09
   117          4.5719E-08
   118          2.0422E-07
   119          6.0309E-07
   120          1.1979E-06
   121          1.6822E-06
   122          1.7181E-06
   123          1.6154E-06
   124          1.5473E-06
   125          9.8408E-07
```

```
MESOFILE II TEST CASE - NONGRIDDED RECEPTORS


************************************************************************************************************************************

ROUTINE CALLED     POLLUTANT            ARRAY SIZE     STARTING RECORD OF DISK OUTPUT      RECEPTOR TYPE
     DEFN             SO4                  10 X 12                        49                  NONGRIDDED


************************************************************************************************************************************

ROUTINE CALLED  DEFINES RUNSTREAM NO.     LOGICAL UNIT    YR/DAY/HR   NO. GRIDS
     FIND                1                       20       78/235/ 1        24


************************************************************************************************************************************

ROUTINE CALLED   AVERAGING TIME    PRINTER OUTPUT   DISK OUTPUT     PLOT   CONTOUR LEVELS    INPUT FIELDS PRINTED
     AVRG               24              YES         NO  (  0-  0)   NO        DEFAULT                  NO

RUNSTREAM NO.    ORDER            A                B          IFORM
      1          FIRST        .10000E+01       .00000E+00       2


************************************************************************************************************************************
```

E5

Date ____________________

James M. Godowitch
Meteorology and Assessment Division (MD-80)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

I would like to receive future revisions to the User's Guide for MESOPUFF II

Name ____

Organization ________________________________
____

Address _____________________________________

City _________________ State _____ Zip _____

Additional Information (Optional):

Phone (   ) ____ - _______

Computer System _____________________________

Compiler ____________________________________